3. SULPHUR RIVER BASIN

TABLE OF CONTENTS

TABLE OF CONTENTS—Continued

TABLES

FIGURES

3. SULPHUR RIVER BASIN

BACKGROUND AND CURRENT CONDITIONS

Physical Description

The Sulphur River Basin in Texas is bounded on the north by the Red River Basin, on the west by the Trinity River Basin, on the south by the Sabine and Cypress Creek Basins, and on the east by the Texas-Arkansas boundary. The Sulphur River joins the Red River in Arkansas. Originating in southeastern Fannin County, the North Sulphur River flows eastward, joining the South Sulphur River at a streambed elevation of about 330 feet. From an elevation of about 600 feet in south-central Fannin County, the South Sulphur River flows southeast past Commerce, then eastward, joining the Middle Sulphur River at a streambed elevation of about 420 feet. The Sulphur River exits Texas in Bowie County above the confluence with the Red River in Arkansas. Total basin drainage area in Texas is 3,558 square miles. For planning purposes, the Sulphur River Basin is treated as a single hydrologic unit (Figure III-3-1).

Surface Water

Average annual runoff for the Sulphur River Basin in Texas during the 1941-70 period varied from approximately 600 acre-feet per square mile in the western part to 1,000 acre-feet per square mile in the easternmost part of the basin. Lowest flows in consecutive years for the 1941-56 period occurred during 1955 and 1956, when average annual runoff was 230 and 162 acre-feet per square mile, respectively. Runoff rates in the western part of the basin were 146 and 124 acre-feet per square mile in 1955 and 1956, respectively.

Due to channel rectification of the North Sulphur River, floods in this stream differ greatly from those in the South Sulphur River. Floods in the North Sulphur River characteristically rise and fall rapidly, rarely go beyond bankfull, and have high flow velocities.

The South Sulphur River and its tributaries have small main channels and wide, timbered floodplains. Consequently, floodwaters have lower velocities and extend beyond bankfull levels for long periods of time.

The surface-water resources of the Sulphur River Basin are generally of good quality. Treated municipal and industrial waste discharges are small, particularly in the western part of the basin where the North Sulphur, Middle Sulphur, and South Sulphur Rivers originate. The Sulphur River also receives flow from White Oak Bayou before reaching Lake Wright Patman and then crossing into Arkansas.

Concentrations of dissolved solids average about 250 milligrams per liter (mg/l) in the North Sulphur River and about 150 mg/l in the South Sulphur. White Oak Bayou contains good quality water above the Talco oil field; however, the quality is impaired in the lower reach of the stream. Flood runoff in this area has been sufficient, however, to dilute saline inflows. The concentration of total dissolved solids in Lake Wright Patman on the main stream of the Sulphur River generally ranges between 100 and 150 mg/l.

Ground Water

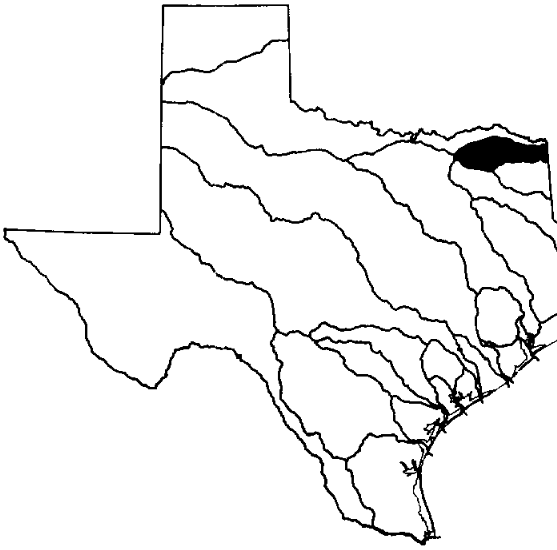
The Trinity Group Aquifer occurs in the western part of the Sulphur River Basin. Total thickness ranges to approximately 1,000 feet. Yields of large-capacity wells completed in the aquifer in adjacent basins average about 430 gallons per minute (gpm). The quality of water in the aquifer ranges from about 1,000 to 3,000 mg/l total dissolved solids.

The Carrizo-Wilcox Aquifer occurs in the south and eastern parts of the basin. Thickness ranges from about 500 to 900 feet. Yields of large-capacity wells average about 275 gpm, but locally wells produce up to 700 gpm. Ground water in the aquifer generally contains less than 500 mg/l total dissolved solids.

The Woodbine Aquifer occurs in a small area in the western part of the basin. Total thickness ranges from 400 to 600 feet. Yields of large-capacity wells completed in the aquifer in nearby basins average about 150 gpm. The quality of water in the aquifer generally exceeds 1,000 mg/l total dissolved solids.

The Blossom Sand Aquifer occurs in a narrow band across the northern edge of the basin. Maximum thickness is about 400 feet. Yields of high-capacity wells range upward to a maximum of about 500 gpm, but the average yield of most wells is much lower. The quality of water in the aquifer ranges from less than 1,000 to 3,000 mg/l total dissolved solids.

The Nacatoch Sand Aquifer occurs in a narrow band across the western part of the basin. Total thickness ranges from 350 to 500 feet. It produces usable-quality water in most places to a depth of about 800 feet. Maximum yields of large-capacity wells reach 500 gpm, but average consid-



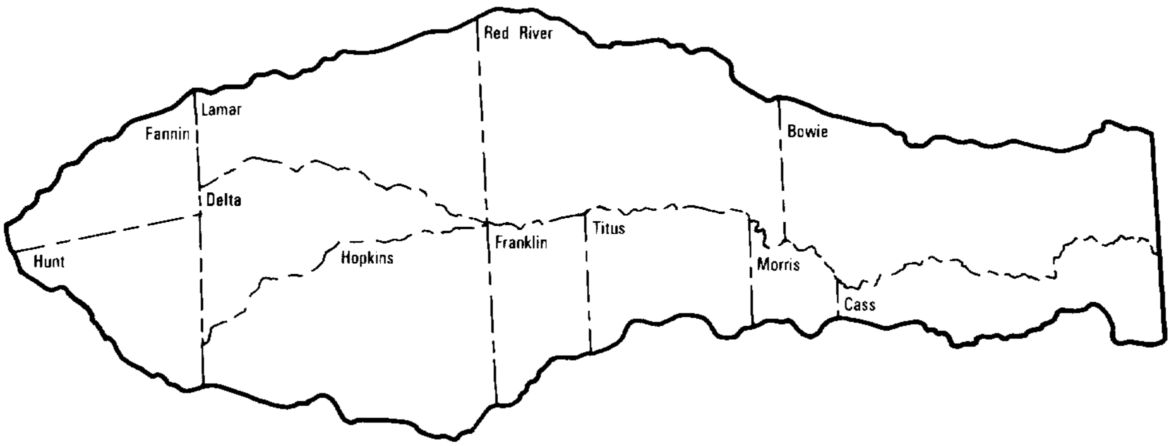


Figure III-3-1. Sulphur River Basin

erably less. The water in the aquifer generally contains less than 1,000 mg/l total dissolved solids, but salinity increases with depth.

The Queen City Aquifer occurs in the southeastern part of the basin. The aquifer ranges to about 500 feet in total thickness. Well yields are generally less than 250 gpm. Water in the aquifer generally contains less than 500 mg/l total dissolved solids; salinity increases with depth.

Saline-water encroachment is a potential problem within the basin due to local heavy withdrawals of ground waters from the Woodbine, Nacatoch, and Blossom Aquifers.

Water in the Carrizo-Wilcox and Queen City Aquifers in the Sulphur River Basin is generally suitable for most purposes; however, both aquifers produce water with relatively high iron concentrations throughout much of the basin. Water in the Queen City Aquifer is generally corrosive, as is water in the Carrizo-Wilcox Aquifer. Locally, the concentration of fluoride in the Woodbine, Nacatoch, and Blossom Aquifers exceeds the Interim Primary Drinking Water Standards promulgated by the Environmental Protection Agency—Texas Department of Health primary standards for fluoride.

Population and Economic Development

The population of the Sulphur River Basin was reported at 154.0 thousand in 1980. Texarkana, the largest city in the basin, had a 1980 in-basin population of 31.0 thousand. The economy of the area is based primarily on agriculture, agribusiness, and to a lesser extent on manufacturing, government employment, and tourism. Hopkins County, located within the basin, is the leading dairy county in Texas. Mineral activities in the basin are principally confined to oil, gas, and clay production.

Water Use

Municipal water use in the Sulphur River Basin totaled 28.1 thousand acre-feet in 1980. Bowie County accounted for 15.2 thousand acre-feet or 54 percent of basin municipal use. The city using the most significant quantity of water was Texarkana, 40 percent, of the total, including that portion of the city in Arkansas. Almost 99 percent of the 45.1 thousand acre-feet of freshwater use for manufacturing occurs in Bowie, Cass, and Lamar Counties. Major industries using significant quantities of water include food and related products, fabricated metal products, and paper and allied products.

In 1980, there was 110 megawatts of steam-electric power generating capacity in the Sulphur River Basin. The plant has an annual forced evaporation of about 150 acre-feet of surface water. In addition, estimated net natural evaporation from the cooling reservoir exceeds 1,600 acre-feet per year. Thus, total surface-water consumption was 1,750 acre-feet per year. An additional 187 acre-feet of ground water was also used.

In 1980, there were only about 1.8 thousand acre-feet of water used for irrigation in the basin.

Estimated mining water use in 1980 in the basin totaled 1.3 thousand acre-feet of freshwater of which 736 acre-feet was utilized for the mining of nonmetals. The remaining 591 acre-feet was used for fuel production.

Livestock water use in the Sulphur River Basin during 1980 totaled 6.5 thousand acre-feet, with an estimated 2.6 thousand acre-feet from ground water and 3.9 thousand acre-feet from surface water.

Return Flows

In 1980, municipal and manufacturing return flows totaled 15.8 thousand acre-feet in the Sulphur River Basin.

Current Ground-Water Development

Approximately 11.2 thousand acre-feet of ground water was used in 1980 in the Sulphur River Basin. The most developed aquifers within the basin are the Carrizo-Wilcox, Nacatoch, and Blossom. Over 50 percent of the ground water used in the basin in 1980 was from the Carrizo-Wilcox Aquifer.

Of the 11.2 thousand acre-feet of ground water used in the basin, about 7.1 thousand acre-feet or 64 percent was for municipal purposes.

Overdrafts of ground water for mainly municipal purposes occurred in the Carrizo-Wilcox Aquifer in Bowie, Cass, Franklin, and Morris Counties; in the Nacatoch Aquifer in Hunt County; and in the Blossom Aquifer in Red River County.

Current Surface-Water Development

Since December 1980 Texas use of water in the Sulphur River Basin has been subject to the Red River Compact.

Lake Wright Patman was constructed and is operated by the U.S. Army Corps of Engineers for flood-control purposes. In 1958, the Cities of Texarkana, Texas and Texarkana, Arkansas contracted with the federal government to reserve part of the storage capacity of the reservoir for water-supply purposes. In 1968, the City of Texarkana, Texas contracted with the federal government to make available, on an interim basis, an additional supply of water for municipal and industrial purposes through modification of the reservoir operating rules. Total use from Lake Wright Patman in 1980 was about 51.8 thousand acre-feet, with the Cities of Texarkana, Texas and Texarkana, Arkansas using about 13.6 thousand acre-feet. About three thousand acre-feet of this total was delivered to the Cities of Wake Village, Hooks, New Boston, Maud, DeKalb, Avery, Annona, Atlanta, and Oak Grove. In addition, International Paper Company has contracted with the City of Texarkana, Texas to purchase raw water, in an amount up to 118 thousand acre-feet annually, for operation of its paper mill which is located near the Sulphur River downstream from Lake Wright Patman Dam. This includes process water and water required for operation of the plant's waste treatment facilities in accordance with the current State-Federal National Pollutant Discharge Elimination System permit provisions and present stream-quality standards for the Sulphur River.

Lake Sulphur Springs, located on White Oak Creek, is owned and operated by the City of Sulphur Springs. It provides municipal water supplies for the city and rural areas and various manufacturing plants served by the city in Hopkins County. The City of Sulphur Springs also supplies water to the City of Cooper and rural areas in Delta County. Approximately 2.9 thousand acre-feet of water was diverted from the reservoir in 1980.

The Cooper Lake and Channels Project, on the South Sulphur River, is a multipurpose federal project which was under construction by the Corps of Engineers when halted by an order of the U.S. District Court in 1971 pursuant to litigation filed under provisions of the National Environmental Policy Act of 1969. In July 1984, the 5th U.S. Circuit Court of Appeals overturned the construction injuction by the U.S. District Court. Appeal of this latest decision is a possibility, thereby continuing litigation on this project. The Sulphur River Municipal Water District holds water rights to 26.282 percent of the 273.0 thousand acre-feet of conservation storage which the project will develop, when completed, as well as the right to divert its proportional share of the yield for use by the District's customers. Upon completion of Cooper Lake, 120.0 thousand acre-feet of flood-control storage in Lake Wright Patman will be transferred to Cooper Reservoir, thus increasing the water-supply storage in Lake Wright Patman.

River Crest Reservoir, the remaining major reservoir in the basin, is an off-channel storage facility which provides water for steam-electric power plant cooling. Under permit provisions, up to 10.0 thousand acre-feet of water can be diverted annually from the Sulphur River, under specified river-flow conditions, into River Crest Reservoir to maintain a constant operating level.

The City of Commerce, although supplied partially by ground water pumped from the Nacatoch Aquifer, obtained about 900 acre-feet of surface-water supplies in 1980 from Lake Tawakoni in the Sabine River Basin through agreements with the Sabine River Authority. Pumping and pipeline facilities for the City of Commerce have the capability of delivering up to 10.0 thousand acre-feet of water annually from Lake Tawakoni to the city.

The City of Paris, part of which lies within the Sulphur River Basin, and domestic and manufacturing users which the city serves are supplied from Lake Creek and Lake Pat Mayse, both located in the Red River Basin.

Water Rights

A total of 367,292 acre-feet of surface water was authorized or claimed for diversion and use in the Sulphur River Basin as of December 31, 1983 (Table III-3-1). Municipal use accounted for 50.2 percent of the total amount of water authorized and/or claimed in the basin (Table III-3-2).

Water Quality

The Sulphur River above Lake Wright Patman and Days Creek in the Texarkana area frequently experience low dissolved oxygen and elevated nutrient and fecal coliform levels. These conditions are primarily due to the discharge of treated wastewater. Upon completion of Cooper Reservoir, a minimum water release will be maintained and should alleviate some of these water quality problems in the Sulphur River.

Flooding and Drainage

Since 1953, the Sulphur River Basin has experienced damaging floods 11 times. Basinwide, historic damages tabulated by the Corps of Engineers total in excess of \$9.3 million. Completion of Lake Wright Patman in 1956 has greatly reduced flood potential for the extreme eastern part of the basin. Completion of the Cooper Lake and Channels Project will provide significant additional flood protection for the basin.

Table III-3-1. Authorized or Claimed Amount of Water, by Type of Right, Sulphur River Basin[1]

Type of Authorization	Number of Rights	Acre-Feet Authorized and Claimed
Permits	36	365,552
Claims	43	1,730
Certified Filings	2	10
Certificates of Adjudication	0	0
Total Authorizations and Claims	81	367,292

[1]The Texas Water Rights Adjudication Act of 1967 authorizes the Texas Department of Water Resources to investigate and determine, with the Court's approval, the nature and measure of water rights for all authorized diversions from surface-water streams or portions thereof except domestic and livestock uses and to monitor and administer each adjudicated water right. These totals incorporate the results of water-rights adjudication in the basin as of December 31, 1983. Certified Filings are declarations of appropriation which were filed with the State Board of Water Engineers under the provisions of Section 14, Chapter 171, General Laws, Acts of the 33rd Legislature, 1913, as amended. Permits are statutory appropriative rights which have been issued by the Texas Water Commission or its predecessor agencies. Claims are sworn statements of historical uses to be adjudicated in accordance with the Texas Water Rights Adjudication Act. A certificate of adjudication is the final result after recognition of a valid right in the adjudication process and is based on a permit, certified filing or claim or any combination of the three.

Table III-3-2. Authorized or Claimed Amount of Water, by Type of Use, in Acre-Feet, Sulphur River Basin

Type of Use	Number of Rights	Basin Total
Municipal	16	184,223
Industrial	11	166,412
Irrigation	46	10,143
Recreation	12	6,514
Total	81[1]	367,292

[1]Does not sum due to multipurpose "rights", which may be applied to more than one type of use.

The Federal Emergency Management Agency, has designated 27 communities within the Sulphur River Basin as having one or more potential flood-hazard areas. Sixteen of these cities are participants in the National Flood Insurance Program. Nine participants are eligible for the sale of insurance at subsidized rates and seven cities are eligible for actuarial rates under the regular program. Studies to determine 100-year flood elevations within the Cities of Texarkana and Commerce have been completed.

In the Sulphur River Basin, drainage problems occur in alluvial river bottoms and terraces. If additional timbered areas are cleared for cultivation, on-farm drainage systems must be expanded for good crop production. Channels have been enlarged and levees constructed in local areas to enhance drainage capability of natural outlets and streams. Some of this work was accomplished by the Corps of Engineers in association with the Cooper Lake and Channels Project. At least one-half of the area which is feasible for drainage improvements will need to be provided with lateral ditches to connect farm drainage systems to major outlets and improved stream channels.

Recreation Resources

Lake Wright Patman, with over 20.0 thousand surface acres, accounted for 91 percent of the total surface area of lakes in the Sulphur River Basin available for flat-water recreation. This reservoir, operated by the Corps of Engineers, had a recorded recreation use of more than 4.5 million visits by recreationists during 1980. The Sulphur River, plus Lake Sulphur Springs with 1.3 thousand surface acres and River Crest Lake with 600 surface acres, provides additional water-oriented recreation opportunities.

PROJECTED WATER REQUIREMENTS

Population Growth

The population of the Sulphur River Basin is projected to increase 81 percent by the year 2030, from the present 154.0 thousand (1.1 percent of the State population) to 279.0 thousand (0.8 percent of the State population). A 23 percent increase, to 189.3 thousand, is forecasted from 1980 to the year 2000, and a growth of 47 percent is anticipated for the ensuing 30 years (Table III-3-3). These rates of change are lower than the projected statewide trends of 49 percent and 62 percent, respectively.

The Sulphur River Basin includes the City of Texarkana, in Bowie County, which is one of the fastest growing counties in the basin. Population of Bowie County is projected to increase by 83 percent from 1980 to 2030. The percentage of basin population in Bowie County is expected to increase from 41.6 percent to 42.3 percent.

Table III-3-3. Population, Current Water Use, With Projected Population and Water Requirements, 1990-2030a/
Sulphur River Basin

River Basin Zone & Category of Use	1980			1990			2000			2010			2020			2030		
	Ground Water	Surface Water	Total	Ground Water	Surface Water	Total	Ground Water	Surface Water	Total	Ground Water	Surface Water	Total	Ground Water	Surface Water	Total	Ground Water	Surface Water	Total
Sulphur Basin																		
Population			154.0			171.8			189.3			211.6			242.1			279.0
Municipal	7.1	21.0	28.1	2.9	39.8	42.7	1.9	46.4	48.3	2.0	52.0	54.0	2.1	59.7	61.8	1.8	69.7	71.5
Manufacturing	0.1	45.0	45.1	0.0	51.4	51.4	0.0	59.1	59.1	0.0	81.1	81.1	0.0	106.8	106.8	0.0	122.6	122.6
Steam Electric	0.2	1.7	1.9	0.0	1.9	1.9	0.0	14.7	14.7	0.0	21.6	21.6	0.0	28.4	28.4	0.0	38.3	35.3
Mining	1.2	0.1	1.3	1.3	0.2	1.5	1.4	0.2	1.6	1.5	0.2	1.7	1.5	0.3	1.8	1.6	0.2	1.8
Irrigation	0.0	1.8	1.8	1.0	4.3	5.3	1.0	6.1	7.1	1.0	8.0	9.0	1.0	8.0	9.0	1.0	8.0	9.0
Livestock	2.6	3.9	6.5	0.9	6.7	7.6	0.9	7.9	8.8	0.9	7.9	8.8	0.9	7.9	8.8	0.9	7.9	8.8
Basin Total Water	11.2	73.5	84.7	6.1	104.3	110.4	5.2	134.4	139.6	5.4	170.8	176.2	5.5	211.1	216.6	5.3	243.7	249.0

a/ Population in thousands of persons, water requirements in thousands of acre-feet per year

Water Requirements

Municipal

Municipal water requirements were projected for two cases of future growth based on both population and per capita water use. From 1980 to 2000, municipal water requirements in the Sulphur River Basin are projected to increase 52 percent (high set). From 1980 to 2030, an almost threefold increase is projected, with the majority of the growth occurring in Bowie County.

Industrial

Manufacturing water requirements in 1980 were 45.1 thousand acre-feet in the Sulphur River Basin. Projections of future water requirements for manufacturing purposes were made by decade and for a low and high case for each industrial group. In 1980, over 90 percent of total manufacturing water use was concentrated in five industrial groups: chemicals, petroleum refining, primary metals, paper products, and food products. Because of this concentration, careful attention was given to the future growth outlook for these industries in making the projections.

Basin water requirements will increase to 57.4 thousand acre-feet or 59.1 thousand acre-feet by 2000, low and high cases, respectively. From 2000 to 2030, water demands are projected to increase an additional 56 percent (low set) to 107 percent (high set).

Steam-Electric Power Generation

Although the Sulphur River Basin consumes less than 2000 acre-feet of surface water per year for steam-electric power generation, available near-surface lignite reserves will result in growth. By 2000, water consumption for power-plant cooling is projected to exceed 14 thousand acre-feet per year and, by 2030 be more than 35 thousand acre-feet annually (high case).

Agriculture

Irrigation

Irrigation water requirements were projected for two cases of change based on improvements in on-farm application efficiencies, reduction in ditch losses, changes in future resource costs and crop prices, and corresponding changes in cropping patterns to reflect more profitable crops. A low case projects demand for water based on the effects of changes in the above variables but with irrigated acreage held constant at 1980 levels in each zone for each future time period; a high case projects demand for water for irrigation constrained only by the requirement that irrigated farming produce a net positive return in excess of that possible from dryland farming and the requirement not to exceed the amount of irrigable soil in each zone. Thus, the projections of demand, low and high cases, based on the irrigation efficiency and market conditions mentioned above, give an estimate of the quantity of water needed for irrigation in each zone, at each decadal point for which projections were made. These projections of demand are compared to the projected supply of water locally available. When projected demand exceeds projected supply, the difference is a measure of shortage at that point in time.

Irrigation water requirements in the Sulphur River Basin are projected to increase from the 1980 level of 1.8 thousand acre-feet by a projected threefold increase to the year 2000 in the high case, and declining 38 percent in the low case. In the year 2030, water requirements in the basin are projected to range from 1.1 to 9.0 thousand acre-feet annually, low and high case, respectively, to irrigate from 1.3 thousand acres to 10.2 thousand acres.

Livestock

A slight increase in cattle production is expected to increase livestock water use to more than 8.8 thousand acre-feet by 2000. In 1980, livestock water use was 6.5 thousand acre-feet. By 2030, water use is projected to increase 35 percent over the 1980 use.

Mining

Nonmetal mining water use in 1980 (737 acre-feet) is projected to more than double by 2030, however, water used in the recovery of crude petroleum and natural gas is not expected to exceed 300 acre-feet by the end of the planning period. By 2030, mining water use is projected to increase by 38 percent, 1.8 thousand acre-feet.

Navigation

No navigation facilities are planned in the Sulphur River Basin.

Hydroelectric Power

There are no hydroelectric power generating facilities planned in the Sulphur River Basin.

WATER SUPPLY PROJECTS AND MEASURES TO MEET FUTURE BASIN NEEDS

Ground-Water Availability and Proposed Development

The approximate annual ground-water yield within the Sulphur River Basin to the year 2030 is 14.0 thousand acre-feet with the following amounts annually available by aquifer; 4.0 thousand acre-feet from the Carrizo-Wilcox, 1.3 thousand acre-feet from the Trinity Group, 1.3 thousand acre-feet from the Nacatoch, 0.4 thousand acre-feet from the Blossom, and 7.0 thousand acre-feet from the Queen City. Since the ground water available from the Queen City Aquifer within the basin has high concentrations of iron and high acidity (low pH), it should not be considered a suitable source of water for municipal and most manufacturing purposes. However, Queen City ground water is suitable for irrigation, steam-electric power generation (cooling), mining and livestock watering purposes. At the end of the year 2029, the annual yield of the Trinity Group Aquifer within the basin would be reduced from 1.3 thousand acre-feet to zero, because all of the ground water in recoverable artesian storage would be removed. Since the artesian portion of the Trinity Group Aquifer within the basin does not receive any effective recharge, the yield of the aquifer in the year 2030 is zero. This reduction decreases the total ground-water availability within the basin in 2030 to 12.7 thousand acre-feet.

The projected annual ground-water use within the Sulphur River Basin by decade from 1990 through 2030 is expected to be from 5.2 to 6.1 thousand acre-feet per year (Table III-3-4). The approximate average annual projected ground-water use within the basin is expected to be about 5.5 thousand acre-feet per year. Of the 5.5 thousand acre-feet of average annual projected use, about 51 percent is expected to be from the Carrizo-Wilcox Aquifer, and about 24 percent is expected to be from the Queen City Aquifer.

Surface-Water Availability and Proposed Development

Projected surface-water requirements can be fully satisfied by existing and proposed surface-water projects in the Sulphur Basin through the year 2030 (Table III-3-4, Figure III-3-2). An excess of 244.5 thousand acre-feet of annual surface-water supply is projected to occur in the river basin by 2030. A slight shortage of 6.8 thousand acre-feet for irrigation is estimated to occur due to locally limiting ground-water supplies. The total surface-water supply in the basin is anticipated to be 963.1 thousand acre-feet in year 2030, with imports accounting for 40.4 thousand acre-feet and exports totaling 485.0 thousand acre-feet.

The Sulphur River Basin surface-water needs may be met from existing reservoirs in the basin and imports from adjacent basins through the year 2030. However, major surface-water storage and conveyance facilities will be needed in the Sulphur River Basin to supply water to adjacent river basins, particularly the Trinity River Basin. Water demand and supply analyses indicate that Cooper Reservoir, in the upper basin, would be needed by the year 2000 to meet anticipated increases in the water requirements for municipal and manufacturing use for the City of Irving and the service area for the North Texas Municipal Water District (NTMWD) in the Trinity River Basin. Pipelines connecting Cooper Reservoir to Lake Lavon and the City of Irving would be needed upon completion of the reservoir project. Upon completion of the Cooper Lake and Channels Project, 120.0 thousand acre-feet of flood-control storage will be reallocated from Lake Wright Patman to Cooper Lake, thus increasing the water supply storage capacity in Wright Patman by 120.0 thousand acre-feet.

By the year 2010, the increased needs for the cities serviced by NTMWD are projected to exceed available supplies even with Cooper Reservoir. An alternative for additional surface-water resources is the development of Stage I of George Parkhouse Reservoir, located downstream of Cooper Reservoir.

Increases in water needs for municipal and manufacturing purposes in the upper Trinity River Basin are anticipated to exceed available supplies by the year 2020. These shortages could be met from the development of Stage II of George Parkhouse Reservoir on the North Sulphur River. Water from this project, in addition to waters provided by Cooper and Parkhouse Stage I Reservoirs could be used to meet the year 2020 needs in the Trinity River Basin for the Tarrant County Water Control and Improvement District No. 1 (TCWCID-1) and NTMWD.

Cooper and Parkhouse Reservoirs could supply the increased water needs for NTMWD through the year 2030. However, TCWCID-1 and the City of Dallas are projected to need additional surface-water resources to meet water demands. Stage I of the Marvin C. Nichols Reservoir project downstream of Parkhouse Reservoir could provide this water supply. Conveyance facilities consisting of pipelines and/or open channels would have to be constructed to move available water from Nichols Reservoir to the upper Trinity River Basin.

Table III-3-4. Water Resources of the Sulphur River Basin, With Projected Water Supplies and Demands, 1990-2030[1]

Decade	Water Supply					Water Demand				Surplus or Shortage		
	In Zone	Intra-Basin	Return Flow	Import	Total	In Zone	Intra-Basin	Export	Total	M & I	Irrigation (Shortage)	Total
1990												
Ground Water	6.1	—	—	—	6.1	6.1	—	—	6.1	.0	.0	.0
Surface Water	129.3	—	21.2	19.1	169.6	96.0	—	4.9	100.9	71.8	(3.1)	68.7
Total	135.4	—	21.2	19.1	175.7	102.1	—	4.9	107.0	71.8	(3.1)	68.7
2000												
Ground Water	5.2	—	—	—	5.2	5.2	—	—	5.2	.0	.0	.0
Surface Water	320.6	—	26.4	23.3	370.3	124.5	—	72.6	197.1	178.2	(5.0)	173.2
Total	325.8	—	26.4	23.3	375.5	129.7	—	72.6	202.3	178.2	(5.0)	173.2
2010												
Ground Water	5.4	—	—	—	5.4	5.4	—	—	5.4	.0	.0	.0
Surface Water	446.6	—	32.0	28.0	506.6	160.9	—	115.2	276.1	237.3	(6.8)	230.5
Total	452.0	—	32.0	28.0	512.0	166.3	—	115.2	281.5	237.3	(6.8)	230.5
2020												
Ground Water	5.5	—	—	—	5.5	5.5	—	—	5.5	.0	.0	.0
Surface Water	584.5	—	39.1	33.7	657.3	201.1	—	232.4	433.5	230.6	(6.8)	223.8
Total	590.0	—	39.1	33.7	662.8	206.6	—	232.4	439.0	230.6	(6.8)	223.8
2030												
Ground Water	5.3	—	—	—	5.3	5.3	—	—	5.3	.0	.0	.0
Surface Water	875.3	—	47.4	40.4	963.1	233.6	—	485.0	718.6	251.3	(6.8)	244.5
Total	880.6	—	47.4	40.4	968.4	238.9	—	485.0	723.9	251.3	(6.8)	244.5

[1]Units in thousands of acre-feet per year. Water demands are for the "high" case. Tabulated surface water demands do not include livestock needs, some quantities of irrigation needs and other needs which will continue to be met from local, unregulated surface-water supplies.

Definitions

Intra-Basin: A transfer of water among zones within a river basin.
Import: A transfer of water from another river basin.
Return Flows: Wastewater returned to a natural stream channel that can be recaptured at a downstream point.
Export: A transfer of water to another river basin.

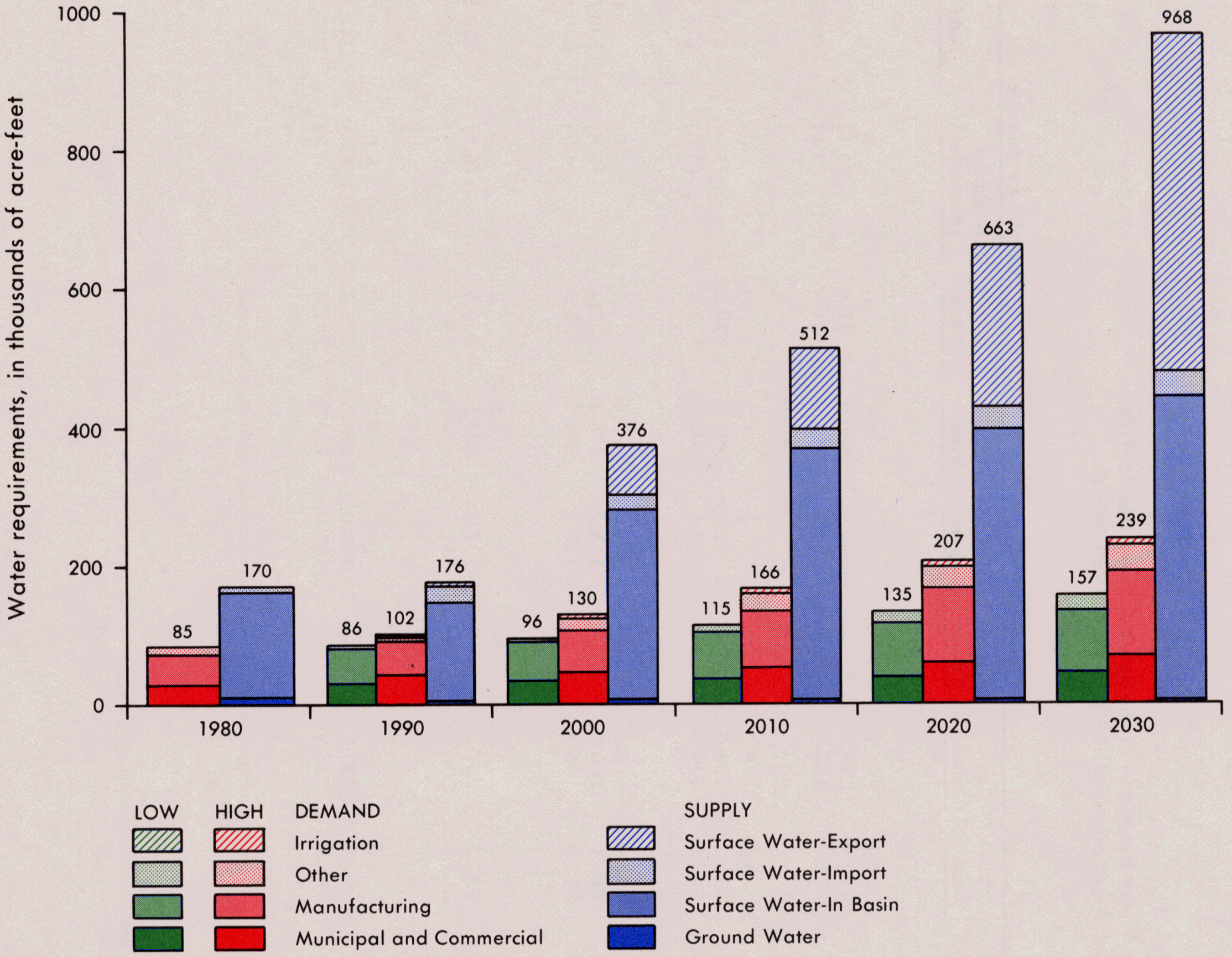


Figure III-3-2. Reported Use and Supply Source, With Projected Water Supplies and Demands, Sulphur River Basin, 1980-2030

Additional studies will have to be performed by the Department and regional interests to examine the engineering alternatives and the economic, environmental, and institutional considerations that would be involved in such major interbasin transfers of water as proposed above.

Water Quality Protection

A water quality management plan for the Sulphur River Basin has been developed pursuant to the requirements of federal and State Clean Water legislation. An areawide water quality management plan has also been developed for the Texarkana metropolitan area. The purpose of these plans is to provide information for use in making water quality management decisions. The plans serve as a basic element in the State's overall water quality strategy and provide guidance in establishing priorities for construction grants for waste treatment facilities, permitting of wastewater facilities, revision of stream standards, and other program activities.

Construction costs associated with municipal wastewater treatment facilities needs have been estimated to be approximately $65.6 million for the planning period of 1980 to the year 2000. These costs are estimated for the entire Sulphur River Basin in January 1980 dollars and are subject to revision as new data become available. The list of projects, with project costs for 1982-1989, at 1980 prices, is shown in Appendix B.

Additional water quality management costs, such as for control of industrial, agricultural, and oil and gas pollutants, cannot be estimated at this time, but are believed to be increasing.

Flood Control Measures

Wright Patman Reservoir is presently the only reservoir in the basin with flood-control storage capacity, which totals 2.5 million acre-feet; however, it is planned to reallocate part of the flood-control storage to Cooper Lake, as previously described.

Construction of floodwater-retarding structures in the basin by the U.S. Department of Agriculture, Soil Conservation Service includes 40 square miles of drainage area above 25 existing floodwater-retarding structures. As of October 1980 there were no additional structures planned for construction.

4. CYPRESS CREEK BASIN

TABLE OF CONTENTS

TABLE OF CONTENTS—Continued

TABLES

FIGURES

4. CYPRESS CREEK BASIN

BACKGROUND AND CURRENT CONDITIONS

Physical Description

The Cypress Creek Basin is bounded on the north by the Sulphur River Basin, on the west and south by the Sabine River Basin, and on the east by the Texas-Arkansas and Texas-Louisiana state boundaries. The headwaters of Big Cypress Creek form in southeastern Hopkins County at a streambed elevation of 445 feet. Big Cypress Creek is joined from the north by Boggy Creek near Lone Star and becomes Big Cypress Bayou in Marion County. Lily Creek and Carney Creek join to form Little Cypress Creek near Gilmer, becoming Little Cypress Bayou in Harrison County. Big Cypress Bayou and Little Cypress Bayou join at the boundary of Marion and Harrison Counties at a streambed elevation of about 170 feet. The Cypress Creek Basin empties into the Red River near Shreveport, Louisiana. Total basin drainage area in Texas is 2,812 square miles. For planning purposes, the basin is treated as a single hydrologic unit (Figure III-4-1).

Surface Water

The average runoff in the Cypress Creek Basin in Texas during the period 1941 through 1958 was 696 acre-feet per square mile. The lowest consecutive runoff rates during the 1941-58 period occurred in 1954, 1955, and 1956, when runoff rates averaged 256, 248, and 122 acre-feet per square mile, respectively.

Floods frequently occur in the Cypress Creek Basin. Floods generally rise and fall slowly and have relatively low flow velocities. Heavily timbered flood plains retard surface runoff and create natural obstructions to flood flows, causing additional backwater problems.

Principal streams of the Cypress Creek Basin flow through dense, undeveloped forested areas. The quality of water in these streams and existing reservoirs is generally good. Dissolved-solids concentrations average between 50 to 200 milligrams per liter (mg/l) in the principal streams, and about 100 mg/l in Lake O' the Pines on Big Cypress Creek.

Ground Water

The Carrizo-Wilcox Aquifer occurs over the entire Cypress Creek Basin. Yields of high-capacity wells average 200 gallons per minute (gpm), but locally wells produce up to 900 gpm. The water generally contains less than 500 mg/l total dissolved solids.

The Queen City Aquifer occurs in a wide band across the central part of the basin. Total thickness ranges up to about 500 feet. Well yields are generally low, but locally wells produce as much as 200 gpm. Water in the aquifer generally contains less than 500 mg/l total dissolved solids.

Ground waters contained in the shallow water-bearing sands of the Carrizo-Wilcox and Queen City Aquifers within the basin usually have excessive concentrations of iron and low pH (high acidity) values. Also, due to excessive pumpage, saline-water encroachment may occur from saline water-bearing sands laterally adjacent to or beneath the fresh water-bearing sands of the aquifers.

Population and Economic Development

The population of the Cypress Creek Basin was reported at 118.2 thousand in 1980. Mount Pleasant is the largest population center in the basin. The economy of the Cypress Creek Basin is based on agriculture, agribusiness, manufacturing, paper and wood products, and steel production. Oil and gas processing and tourism round out the basin economy. Mineral activities in the basin include lignite mining and the production of gas, oil, iron ore, sand, gravel, and clay.

Water Use

Municipal water use in the Cypress Creek Basin in 1980 totaled 15.6 thousand acre-feet. The City of Mount Pleasant, in Titus County, used 10 percent of the total basin municipal water in 1980; 51 percent of the total basin use was in rural areas or in cities and communities of less than one thousand population.

Manufacturing industries in the Cypress Creek Basin used 198.4 thousand acre-feet of freshwater in 1980. Most of the water use was concentrated in Harrison, Morris, and Titus Counties where food and kindred products, chemicals, petroleum, and primary metals establishments are the major water-using industries.

In 1980, there was 3,885 megawatts of steam-electric power generating capacity in the Cypress Creek Basin. Surface-water consumption (including net evaporation) for power generation was 29.6 thousand acre-feet

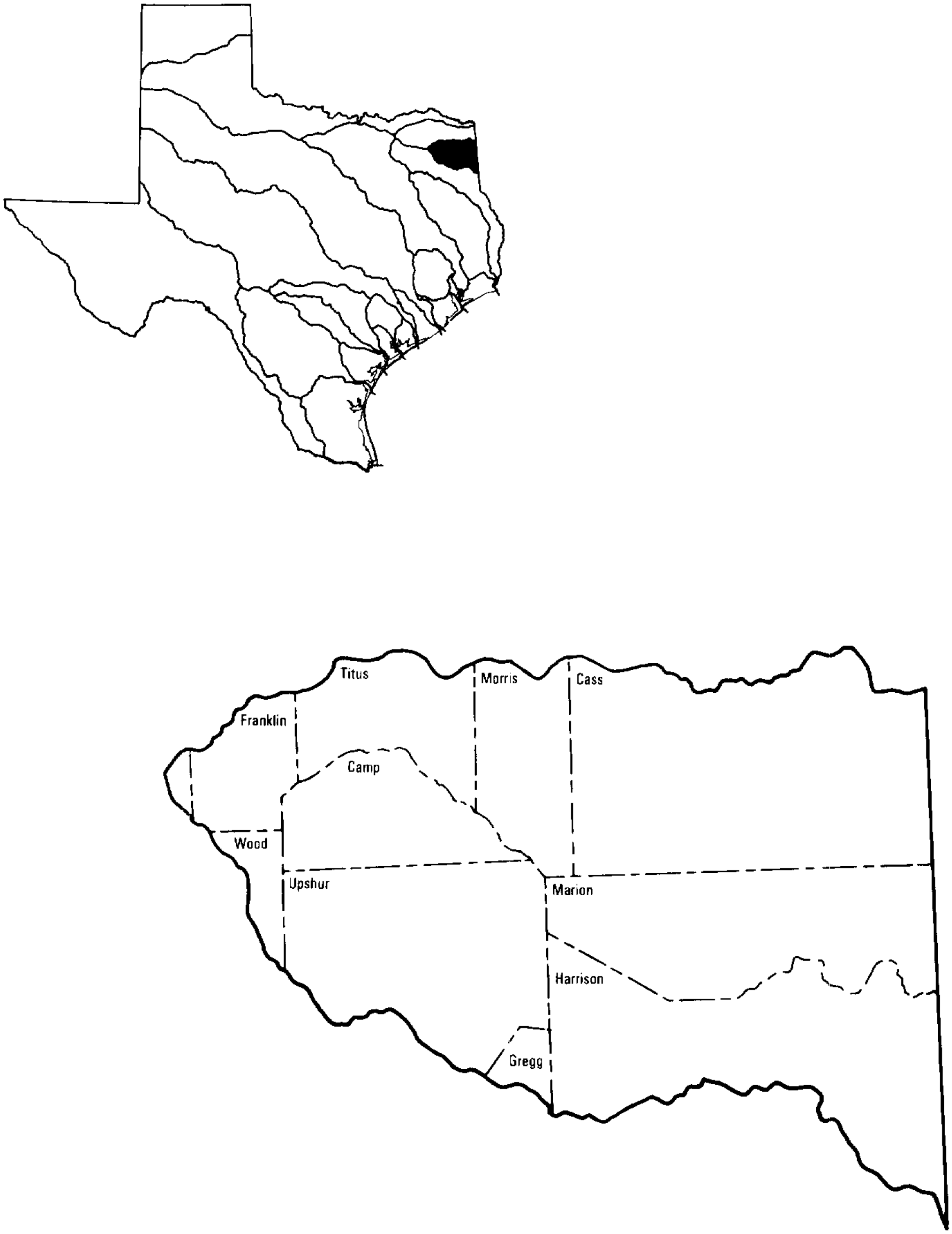


Figure III-4-1. Cypress Creek Basin

during 1980 while ground-water consumption totaled 62 acre-feet. Net evaporation from power plant cooling reservoirs was estimated at 9.5 thousand acre-feet in 1980.

In 1980, irrigation use was only 0.5 thousand acre-feet in the Cypress Creek Basin. Although small acreages have been irrigated periodically with ground water, none was used in 1980. Irrigation is not expected to become widespread in the basin, as rainfall is generally adequate for the production of grazing and feed crops grown in the area.

Estimated freshwater withdrawals associated with nonmetal production (primarily sulfur) accounted for approximately 25 percent of the total mining water use (1.9 thousand acre-feet) in the Cypress Creek Basin in 1980. The largest mining water use was in Harrison County, where 243 acre-feet of fresh water was used for petroleum production.

Livestock water use in 1980, principally for cattle production, totaled about 3.4 thousand acre-feet in the basin. Of this 1.8 thousand acre-feet was surface water.

Return Flows

In 1980, reported municipal and manufacturing return flows totaled 108.5 thousand acre-feet in the Cypress Creek Basin. Steel production in Morris County accounted for most of this return flow.

In the Cypress Creek Basin, irrigation is expected to continue with water diverted directly from streams, small impoundments, farm ponds, or pumped from wells. This small amount of scattered irrigation is not anticipated to produce any significant volumes of return flows.

Current Ground-Water Development

Approximately 14.7 thousand acre-feet of ground water was used in 1980 in the Cypress Creek Basin. The Carrizo-Wilcox and Queen City Aquifers are the only fresh to slightly saline water-bearing formations occurring within the basin. In 1980, about 75 percent of the ground water used in the basin was from the Carrizo-Wilcox Aquifer.

Of the 14.7 thousand acre-feet of ground water used in the basin, about 10.7 thousand acre-feet or 73 percent was for municipal purposes.

Overdrafts of ground water for municipal purposes occurred in Upshur County from the Carrizo-Wilcox Aquifer.

Current Surface-Water Development

There are eight major reservoirs in the Cypress Creek Basin: Cypress Springs, Bob Sandlin, Lake O' the Pines, Monticello, Welsh, Ellison Creek, Johnson Creek, and Caddo. Caddo Lake lies partly within Texas and partly in Louisiana, with Caddo Dam located in Louisiana. Since December 1980, Texas use of water in the Cypress Creek Basin has been subject to the Red River Compact.

Lake Cypress Springs, located near the headwaters of Big Cypress Creek, is owned by the Franklin County Water District. The District currently supplies raw water to the City of Mount Vernon, located in the Sulphur River Basin, and has commitments to serve rural areas in the Franklin County area through the South Franklin Water Supply Corporation. Also, up to 3.8 thousand acre-feet annually is committed to Texas Utilities Generating Company for steam-electric power plant cooling. Lake Bob Sandlin, owned and operated by the Titus County Fresh Water Supply District No. 1 just downstream from Lake Cypress Springs, supplies the municipal and manufacturing water needs of the City of Mount Pleasant, and supplies up to 38.5 thousand acre-feet of water annually to Texas Utilities Generating Company for steam-electric power plant cooling.

Lake O' the Pines, located downstream from Lake Bob Sandlin, was constructed and is operated by the U.S. Army Corps of Engineers for flood control and water-supply purposes. The Northeast Texas Municipal Water District owns the 251 thousand acre-feet of conservation storage in the reservoir and presently supplies municipal and manufacturing water to the Cities of Daingerfield, Lone Star, and Hughes Springs as well as industrial use described below.

Monticello, Ellison Creek, Welsh, and Johnson Creek Reservoirs are located on tributaries of Big Cypress Creek and all serve manufacturing and steam-electric power plant cooling water needs. Monticello Reservoir, located on Blundell Creek, was constructed by Dallas Power and Light Co. and others, to supply cooling water and other water required for operation of steam-electric power plants near the reservoir. In order to maintain a constant operating level necessary for power plant operation, make-up water is diverted to Monticello Reservoir from Lake Bob Sandlin, as necessary, pursuant to water supply contracts with Titus County Fresh Water Supply District No. 1, Franklin County Fresh Water Supply District, and Dallas Power and Light Co. Welsh Reservoir, located on Swauano Creek, is owned by Southwestern Electric Power Company and provides cooling water and other water requirements for operation of the steam-electric power plant located at the reservoir. The reservoir is maintained at constant operating level by supplemental diversions, as necessary, from Lake O' the Pines through a contractual agreement with the Northeast Texas Municipal Water District. Ellison Creek Reservoir, owned by Lone Star Steel Co., supplies water for its steel mill located near Daingerfield. Through prior water rights held by the company to the flows of Cypress Creek, supplemental water is diverted from Cypress Creek into Ellison Creek Reservoir. In 1980, a total of 195.6 thousand acre-feet of water was diverted from the combined Cypress Creek-Ellison Creek Reservoir supply system for industrial use. Johnson Creek Reservoir, located on Johnson Creek, is owned by Southwestern Electric Power Company. The reservoir supplies cooling water and other water needs associated with operation of the company's steam-electric power plant located at the reservoir and is maintained at a constant operating level by diversions, as necessary, from Lake O' the Pines.

Caddo Lake, on the Louisiana border, is created by Caddo Dam on Big Cypress Bayou in Caddo Parish, Louisiana. The lake is owned and operated by the Caddo Lake Levee District. The original dam, constructed in 1914 by the federal government for local navigation purposes, was reconstructed by the Corps of Engineers in 1971. The City of Marshall diverts water from Big Cypress Bayou. In 1980, the city diverted about 7.1 thousand acre-feet of water from Cypress Creek. Oil City and Mooringsport, Louisiana currently withdraw municipal supplies from Caddo Lake. Cooling water is also withdrawn from the lake by a steam-electric power plant located near Mooringsport. The Red River Compact provides that each state shall have unrestricted right to use 50 percent of the conservation storage capacity, subject to the provision that supplies for existing uses of water from the lake on date of Compact, are not reduced.

Owing to the complexities arising from the appropriation of waters of the Cypress Creek Basin, and the rapid development and use of the basin supplies, extensive hydrologic studies of the basin have been performed which led to the development of an operating agreement between the Franklin County Water District, the Titus County Fresh Water Supply District No. 1, the Northeast Texas Municipal Water District, the Texas Water Development Board, and Lone Star Steel Company. The agreement, approved by the participants in 1972 includes rules for the operation of reservoirs owned by various entities and provisions for accounting for the waters held in storage. In 1973, the Texas Water Rights Commission adopted an order approving the operating agreement. Basically, the agreement provides that Lakes Cypress Springs and Bob Sandlin can impound and store water previously appropriated to downstream entities (specifically Lake O' the Pines and Lone Star Steel Company) subject to call for releases from upstream storage to satisfy downstream requirements as needed. The agreement establishes storage accounts in the main stem reservoirs and Ellison Creek Reservoir such that the basin waters are appropriately divided, in accordance with existing water rights, through exchange of storage.

Water Rights

A total of 422,013 acre-feet of surface water was authorized or claimed for diversion and use in the Cypress Creek Basin as of December 31, 1983 (Table III-4-1). Municipal use accounted for 22.7 percent of the total amount of water authorized and/or claimed in the basin (Table III-4-2).

Water Quality

Some streams in the Cypress Creek Basin periodically exhibit low dissolved-oxygen concentrations. This problem is caused by the discharge of treated sewage and is compounded by low stream discharge rates and low reaeration rates characteristic of streams in the area. Cypress Creek above Lake O' the Pines experiences periodic low dissolved-oxygen concentrations under low-flow conditions. Black Bayou occasionally experiences low dissolved-oxygen concentrations, as the result of the discharge of

Table III-4-1. Authorized or Claimed Amount of Water, by Type of Right, Cypress Creek Basin[1]

Type of Authorization	Number of Rights	Acre-Feet Authorized and Claimed
Permits	54	417,485
Claims	97	4,528
Certified Filings	0	0
Certificates of Adjudication	0	0
Total Authorizations and Claims	151	422,013

[1]The Texas Water Rights Adjudication Act of 1967 authorizes the Texas Department of Water Resources to investigate and determine, with the Court's approval, the nature and measure of water rights for all authorized diversions from surface-water streams or portions thereof except domestic and livestock uses and to monitor and administer each adjudicated water right. These totals incorporate the results of water-rights adjudication in the basin as of December 31, 1983. Certified Filings are declarations of appropriation which were filed with the State Board of Water Engineers under the provisions of Section 14, Chapter 171, General Laws, Acts of the 33rd Legislature, 1913, as amended. Permits are statutory appropriative rights which have been issued by the Texas Water Commission or its predecessor agencies. Claims are sworn statements of historical uses to be adjudicated in accordance with the Texas Water Rights Adjudication Act. A certificate of adjudication is the final result after recognition of a valid right in the adjudication process and is based on a permit, certified filing or claim or any combination of the three.

Table III-4-2. Authorized or Claimed Amount of Water, by Type of Use, in Acre-Feet, Cypress Creek Basin

Type of Use	Number of Rights	Basin Total
Municipal	13	95,729
Industrial	16	310,824
Irrigation	108	7,056
Mining	1	282
Recreation	23	8,122
Total	151[1]	422,013

[1]Does not sum due to multipurpose "rights", which may be applied to more than one type of use.

treated wastewaters in the Atlanta area. James (Jim's) Bayou also has low dissolved-oxygen concentrations. This condition results also from the discharge of treated sewage, low stream discharge rates and low reaeration rates.

Flooding and Drainage

Very few estimates of dollar losses due to flooding are available for the Cypress Creek Basin. Floods in April and June of 1957 caused an estimated $420 thousand in damages to agriculture and nonagricultural properties. It has been estimated that the May 1958 flood in Atlanta and vicinity caused damages in excess of $1 million to highways and bridges. Minor flooding in Jefferson in 1979 and Mount Pleasant in 1981 produced three flood insurance claims for slightly over $11 thousand in flood damages.

Within the Cypress Creek Basin, 18 cities have one or more flood-hazard areas within their corporate limits. Maps identifying areas inundated by the 100-year flood have been prepared for these cities, and work is underway to identify flood plains within unincorporated areas of the basin. Presently, nine of the 18 designated cities have adopted flood plain management standards in compliance with the National Flood Insurance Program.

The most critical drainage problems in the basin occur in the alluvial bottoms and terraces along the major streams. Changes in land use may preclude the necessity for improving drainage, as cultivated lands in the area between Lake O' the Pines and Caddo Lake are being progressively coverted to improved pasture land.

Recreation Resources

The seven reservoirs in the Cypress Creek Basin with capacities of 5.0 thousand acre-feet or more provide over 64.0 thousand surface acres of water available for flat-water recreation. Caddo Lake, which extends into Louisiana, accounts for over 41 percent of this surface area. Caddo Lake State Park, located adjacent to the shoreline of Caddo Lake, provides additional recreation facilities with a recorded 138.0 thousand visits by recreationists during 1980. Lake O'the Pines, with 18.7 thousand surface acres, provides 29 percent of the water surface area available for flat-water recreation in the basin. Almost 4.0 million visits were made to this reservoir by water-oriented recreationists during 1980.

PROJECTED WATER REQUIREMENTS

Population Growth

The population of the Cypress Creek Basin is expected to increase about 99 percent by 2030, from a level of 118.2 thousand in 1980 to over 235 thousand. A 37 percent growth, to almost 162 thousand, is predicted from 1980 to 2000, and an increase of 45 percent is forecast for the period 2000 to 2030 (Table III-4-3).

Cass County, the most populous county with 22 percent of the 1980 basin population, is expected to experience a population growth of 82 percent from 1980 to 2030, when it is expected to account for 20 percent of the 2030 basin population.

Water Requirements

Municipal

Municipal water requirements in the Cypress Creek Basin were 15.6 thousand acre-feet in 1980. Municipal water requirements were projected for two cases of future growth based on population changes, and per capita water use. From the 1980 level, both the high and low projections estimate a near doubling of water use by 2030. By 2000, municipal water use is projected to increase by 32 percent, 20.6 thousand acre-feet (low set), and increase another 35 to 45 percent by 2030. The proportionate share of use among the counties in the basin is projected to remain fairly constant.

Table III-4-3. Population, Current Water Use, With Projected Population and Water Requirements, 1990-2030[a]
Cypress Creek Basin

River Basin Zone & Category of Use	1980			1990			2000			2010			2020			2030		
	Ground Water	Surface Water	Total	Ground Water	Surface Water	Total	Ground Water	Surface Water	Total	Ground Water	Surface Water	Total	Ground Water	Surface Water	Total	Ground Water	Surface Water	Total
Cypress Basin																		
Population			118.2			142.4			161.9			181.5			205.8			235.4
Municipal	10.7	4.9	15.6	8.5	18.8	27.3	9.0	23.0	32.0	9.4	26.4	35.8	9.9	30.7	40.6	10.0	36.5	46.5
Manufacturing	0.9	197.5	198.4	0.3	235.3	235.6	0.3	222.8	223.1	0.3	228.3	228.6	0.3	234.6	234.9	0.3	242.4	242.7
Steam Electric	0.1	29.6	29.7	0.0	38.7	38.7	12.0	46.1	58.1	12.0	63.0	75.0	12.0	80.0	92.0	12.0	97.0	109.0
Mining	1.4	0.5	1.9	1.0	0.7	1.7	0.6	1.0	1.6	3.8	1.1	4.9	7.0	1.2	8.2	10.2	1.3	11.5
Irrigation	0.0	0.5	0.5	0.2	0.3	0.5	0.2	0.4	.6	0.3	0.3	0.6	0.3	0.3	0.6	0.2	0.4	0.6
Livestock	1.6	1.8	3.4	1.2	2.8	4.0	1.4	3.3	4.7	1.2	3.5	4.7	1.2	3.5	4.7	1.0	3.7	4.7
Basin Total Water	14.7	234.8	249.5	11.2	296.6	307.8	23.5	296.6	320.1	27.0	322.6	349.6	30.7	350.3	381.0	33.7	381.3	415.0

a/ Population in thousands of persons, water requirements in thousands of acre-feet per year.

Industrial

Manufacturing water needs in 1980 were 198.4 thousand acre-feet in the Cypress Creek Basin. Projections of future water requirements for manufacturing purposes were made by decade and for a low and high case for each industrial group. In 1980, over 90 percent of total manufacturing water use was concentrated in five industrial groups: chemicals, petroleum refining, primary metals, paper products, and food products. Because of this concentration, careful attention was given to the future growth outlook for these industries in making the projections.

In the low case projection, manufacturing water use is projected to decline 16 percent by 2000, then increase gradually back to near the 1980 level by 2030. The predicted decline in water requirements for manufacturing does not result from an anticipated reduction in economic activity, but from projected major technological improvements in water use efficiency.

The anticipated reduction in industrial water requirements occurs primarily in Morris County. Almost all of the projected reduction in Morris County manufacturing water requirements results from anticipated greater water use efficiency in the production of steel and related primary metals products.

Steam-Electric Power Generation

Rapid development of the vast, near-surface lignite reserves in the Cypress Creek Basin, in conjunction with available water supplies, is projected to spur future growth of steam-electric generating capacity in the basin.

In 1980, 29.7 thousand acre-feet of water was consumed in steam-electric power generation. Future growth in this industry was projected for two electricity demand levels. By 2000, water requirements for power generation are projected to range from 38.7 to 58.1 thousand acre-feet. Water requirements are projected to increase from 2000-2030 by 88 to 99 percent.

Agriculture

Irrigation

Irrigation water requirements were projected for two cases of change based on improvements in on-farm application efficiencies, reduction in ditch losses, changes in future resource costs and crop prices, and corresponding changes in cropping patterns to reflect more profitable crops. A low case projects demand for water based on the effects of changes in the above variables but with irrigated acreage held constant at 1980 levels in each zone for each future time period; a high case projects demand for water for irrigation constrained only by the requirement that irrigated farming produce a net positive return in excess of that possible from dryland farming and the requirement not to exceed the amount of irrigable soil in each zone. Thus, the projections of demand, low and high cases, based on the irrigation efficiency and market conditions mentioned above, give an estimate of the quantity of water needed for irrigation in each zone, at each decadal point for which projections were made. These projections of demand are compared to the projected supply of water locally available. When projected demand exceeds projected supply, the difference is a measure of shortage at that point in time.

Irrigation water requirements in the Cypress Creek Basin are projected to increase from the 1980 level of 0.5 thousand acre-feet to 0.6 thousand acre-feet by the year 2000 in the high case, declining 37 percent in the low case. In the year 2030, water requirements in the basin are projected to range from 0.3 to 0.6 thousand acre-feet annually, low and high case, respectively, to irrigate from 0.3 thousand acres to 0.7 thousand acres.

Livestock

Some increase in cattle production is projected for the Cypress Creek Basin. Livestock water requirements by 2000 are estimated to be 4.7 thousand acre-feet annually. Livestock water requirements are projected to increase 38 percent from 1980 to 2030.

Mining

Mining water use in the Cypress Creek Basin, which totaled 1.9 thousand acre-feet in 1980, is projected to decrease 14 percent by 2000. This slight decrease is the result of a decline in quantities of oil and gas available for production in the Cypress Creek Basin. Nonmetal mining water requirements are projected to increase from 465 acre-feet in 1980 to 1,180 acre-feet in 2030. Total mining water use estimates are projected to increase to 11.5 thousand acre-feet by 2030 mostly due to the production of synfuels.

Navigation

As part of the authorized Red River Waterway project, the Corps of Engineers has released a feasiblity report of the economics of navigation between Louisiana and Morris County. If this project becomes economically favorable, availability of lockage water requirements will be studied. At present, no supplemental diversions are anticipated.

Hydroelectric Power

No hydroelectric power generating facilities are planned for the Cypress Creek Basin.

WATER SUPPLY PROJECTS AND MEASURES TO MEET FUTURE BASIN NEEDS

Ground-Water Availability and Proposed Development

The approximate annual ground-water yield within the Cypress Creek Basin to the year 2030 is 250.3 thousand acre-feet with the following amounts annually available by aquifer: 15.8 thousand acre-feet from the Carrizo-Wilcox Aquifer, and 234.5 thousand acre-feet from the Queen City Aquifer. Since the ground water available from the Queen City Aquifer within the basin has high concentrations of iron and high acidity (low pH), it should not be considered a suitable source of water for municipal and most manufacturing purposes. However, Queen City ground water is suitable for irrigation, steam-electric power generation (cooling), mining, and livestock watering purposes. In the year 2030, the yield of the Carrizo-Wilcox Aquifer within the basin would be reduced to the aquifer's average annual effective recharge of 15.0 thousand acre-feet per year. This reduction decreases the total ground water available within the basin in 2030 to 249.5 thousand acre-feet.

The annual ground-water use within the Cypress Creek Basin by decade from 1990 through 2030 is projected to increase from 11.2 to 33.7 thousand acre-feet per year (Table III-4-3). The approximate average annual projected ground-water use within the basin is expected to be about 25.2 thousand acre-feet per year. Of the 25.2 thousand acre-feet of average annual projected use, about 58 percent is expected to be from the Queen City Aquifer, and about 42 percent is expected to be from the Carrizo-Wilcox Aquifer.

Surface-Water Availability and Proposed Development

The Cypress Creek Basin has projected surface-water resources from proposed and existing reservoirs in excess of forecasted water requirements through the year 2030 (Table III-4-4, Figure III-4-2). Approximately 104.8 thousand acre-feet annually is available as surplus in the year 2030 for meeting additional basin municipal and manufacturing demands and for export to adjacent river basins. Surface-water supplies in the basin are projected at 493.8 thousand acre-feet per year in 2030, with 13.1 thousand acre-feet annually proposed for export to other basins.

Projected surface-water needs in the Cypress Creek Basin may be satisfied from existing sources with the exception that anticipated municipal and manufacturing water needs for the City of Marshall and adjacent area are projected to exceed available supplies by the year 1990. An anticipated supply source for additional surface water is the Big Sandy Reservoir project on the Big Sandy Creek tributary of the Sabine River. This project would provide the basin with sufficient quantities of surface water to meet projected needs through the year 2020. The project is needed by 1990.

Between 2020 and 2030, additional surface water will be needed in the Marshall area. Water pumped by pipeline from Toledo Bend Reservoir in the Sabine River Basin is proposed to meet the needs. Additional studies will have to be performed by the Department and regional interests to examine the engineering alternatives and the economic, environmental, and institutional considerations that would be involved in such a interbasin transfer of water.

An alternative additional surface-water supply for the basin is the proposed Little Cypress Reservoir in Harrison County. Feasibility-level studies of construction of the project have been performed by federal, State and local agencies. A project with a water conservation storage capacity of 782.3 thousand acre-feet would yield 284.1 thousand acre-feet of annual water supply during the critical drought period.

The Black Cypress Reservoir project offers potential for the development of additional firm supplies in the basin for use in water-short areas of the State. Reconnaissance-level studies performed by the Department indicate a project could be constructed on Black Cypress Bayou with a total storage capacity of 824.4 thousand acre-feet.

Water Quality Protection

A water quality management plan for the Cypress Creek Basin has been developed pursuant to the requirements of federal and State Water legislation. The plan serves as a basic element in the State's overall water quality strategy and provides guidance in establishing priorities for construction grants for waste treatment facilities, permit-

Table III-4-4. Water Resources of the Cypress Creek Basin, With Projected Water Supplies and Demands, 1990-2030[1]

Decade	Water Supply: In Basin	Intra-Basin	Return Flow	Import	Total	Water Demand: In Basin	Intra-Basin	Export	Total	Surplus or Shortage: M & I	Irrigation (Shortage)	Total
1990												
Ground Water	11.2	—	—	—	11.2	11.2	—	—	11.2	.0	.0	.0
Surface Water	254.9	—	221.0	2.4	478.3	292.7	—	15.0	307.7	170.6	.0	170.6
Total	266.1	—	221.0	2.4	489.5	303.9	—	15.0	318.9	170.6	.0	170.6
2000												
Ground Water	23.5	—	—	—	23.5	23.5	—	—	23.5	.0	.0	.0
Surface Water	254.9	—	211.0	2.9	468.8	292.0	—	14.3	306.3	162.5	.0	162.5
Total	278.4	—	211.0	2.9	492.3	315.5	—	14.3	329.8	162.5	.0	162.5
2010												
Ground Water	27.0	—	—	—	27.0	27.0	—	—	27.0	.0	.0	.0
Surface Water	254.9	—	217.2	3.3	475.4	317.7	—	13.6	331.3	144.1	.0	144.1
Total	281.9	—	217.2	3.3	502.4	344.7	—	13.6	358.3	144.1	.0	144.1
2020												
Ground Water	30.7	—	—	—	30.7	30.7	—	—	30.7	.0	.0	.0
Surface Water	254.9	—	224.5	3.7	483.1	345.2	—	13.0	358.2	124.9	.0	124.9
Total	285.6	—	224.5	3.7	513.8	375.9	—	13.0	388.9	124.9	.0	124.9
2030												
Ground Water	33.7	—	—	—	33.7	33.7	—	—	33.7	.0	.0	.0
Surface Water	254.9	—	233.5	5.4	493.8	375.9	—	13.1	389.0	104.9	(.1)	104.8
Total	288.6	—	233.5	5.4	527.5	409.6	—	13.1	422.7	104.9	(.1)	104.8

[1] Units in thousands of acre-feet per year. Water demands are for the "high" case. Tabulated surface water demands do not include livestock needs, some quantities of irrigation needs and other needs which will continue to be met from local, unregulated surface-face supplies.

Definitions
Intra-Basin: A transfer of water among zones within a river basin.
Import: A transfer of water from another river basin.
Return Flows: Wastewater returned to a natural stream channel that can be recaptured at a downstream point.
Export: A transfer of water to another river basin.

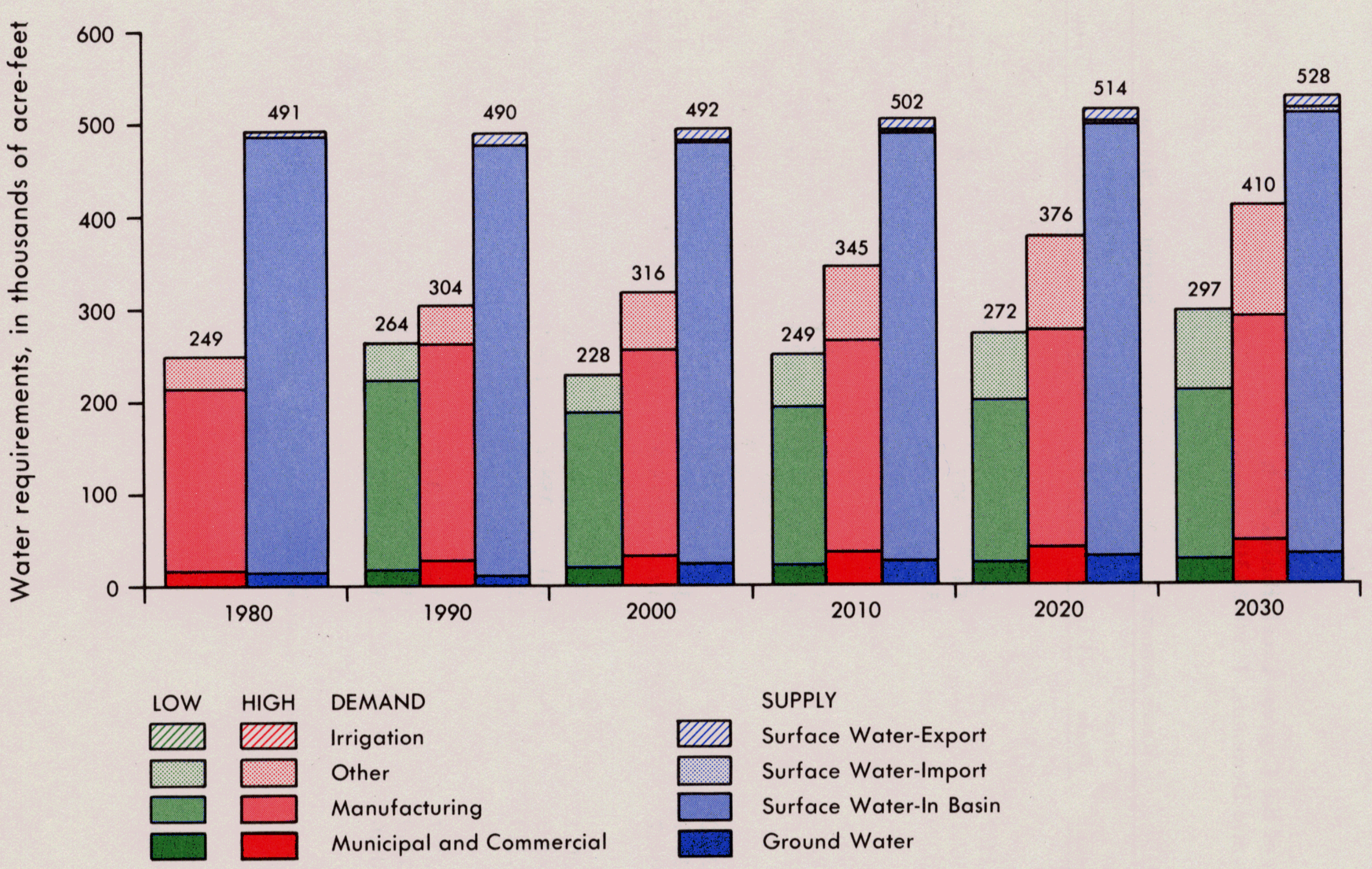


Figure III-4-2. Reported Use and Supply Source, With Projected Water Supplies and Demands, Cypress Creek Basin, 1980-2030

ting of wastewater facilities, revision of stream standards, and other program activities.

Construction costs associated with municipal wastewater treatment facilities needs have been estimated to be approximately $31.2 million for the planning period of 1980 to the year 2000. These costs are estimated for the entire Cypress Creek Basin in January 1980 dollars and are subject to revision as new data become available. The list of projects, with project costs for 1982-1989, at 1980 prices, are shown in Appendix B.

Additional water quality management costs, such as for control of agricultural, oil and gas, and industrial pollutants cannot be estimated at this time, but are believed to be increasing.

Flood Control Measures

Lake O' the Pines is the only reservoir in the Cypress Creek Basin which has flood-control storage as a project purpose. The amount of flood-control storage capacity available is 587.2 thousand acre-feet. No reservoirs are planned by the year 2000 that would provide additional flood-control storage.

The Corps of Engineers has a study underway to determine the feasibility of federal participation in flood-control improvements within the Cypress Creek Basin. This study is scheduled for completion in fiscal year 1985.

5. SABINE RIVER BASIN

TABLE OF CONTENTS

TABLE OF CONTENTS—Continued

TABLES

TABLE OF CONTENTS—Continued

Page

FIGURES

5. SABINE RIVER BASIN

BACKGROUND AND CURRENT CONDITIONS

Physical Description

The Sabine River Basin is bounded on the north by the Sulphur River and Cypress Creek Basins, on the west by the Trinity and Neches River Basins, and on the east by the Red and Calcasieu River Basins. Headwaters of the Sabine River originate in northwest Hunt County at an elevation of about 650 feet. Flowing eastward, the Sabine River is joined by the South Fork at the intersection of Hunt, Van Zandt, and Rains Counties. The Sabine River flows southward from the southeast corner of Panola County, becomes the Texas-Louisiana boundary near Logansport, Louisiana, and continues southward to Sabine Lake on the Gulf Coast. The total basin drainage area is 9,756 square miles, of which 7,426 square miles is in Texas. The Sabine River Basin has been divided into two zones for planning purposes (Figure III-5-1).

Surface Water

Average runoff within about 97 percent of the Sabine River Basin during the 1941-67 period was about 640 acre-feet per square mile. In the southernmost part of the basin near Buna, average runoff in the 1953-70 period was about 687 acre-feet per square mile. The westernmost part of the basin near Quinlan had an average runoff of about 508 acre-feet per square mile during the 1960-70 period. Average runoff for drainage areas west of Logansport, Louisiana was about 530 acre-feet per square mile during the 1941-67 period.

During the 1941-67 period, lowest flows occurred during the 1954-56 and 1963-64 periods when the average runoff was 334 and 229 acre-feet per square mile, respectively. The lowest runoff in the earlier period was 269 acre-feet per square mile (1956) and 210 acre-feet per square mile (1963) in the later period. Low flows of the main stem at Logansport, Louisiana occurred during the same intervals; the average runoff was 226 acre-feet per square mile in the earlier period and 104 acre-feet per square mile in the later period. In 1956 and 1964, the runoff rates were 152 and 82 acre-feet per square mile, respectively.

The Sabine River Basin is characterized by flat slopes and wide, timbered flood plains. Floods generally rise and fall slowly and have low flow velocities, although flash flooding occasionally occurs in the basin. The extreme southern portion of the Sabine River Basin is subject to hurricane flooding.

The main stem of the Sabine River and the majority of its tributaries exhibit good inorganic quality, with discharge-weighted average concentrations of dissolved solids ranging from 100 to 250 milligrams per liter (mg/l). Salinity problems occur locally in the basin in Dry, Lake Fork, Socagee, Rabbit, and Grand Saline Creeks. Mineralization in Grand Saline Creek is a result of natural salt contributions from the Grand Saline Salt Dome, while salinity problems in the other streams result principally from oil-field drainage. Water stored in major reservoirs in the basin generally contains less than 150 mg/l of dissolved solids, and the Sabine River near Ruliff in southern Newton County seldom exceeds 150 mg/l of dissolved solids. Chloride and sulfate concentrations of the basin's surface waters generally fall below 80 and 35 mg/l, respectively.

Ground Water

The Gulf Coast Aquifer occurs throughout the southern part of the Sabine River Basin. This system extends to depths of more than 3,000 feet. Yields of large-capacity wells average about 1,800 gallons per minute (gpm), with some producing 3,500 gpm. Water pumped from the aquifer is generally suitable for most uses. Total dissolved-solids concentrations are commonly less than 500 mg/l.

The Carrizo-Wilcox Aquifer crops out at the surface in the central part and underlies much of the basin. Thickness ranges from zero to 1,600 feet for the entire Carrizo-Wilcox Aquifer. Yields from large-capacity wells average about 275 gpm, but locally wells produce as much as 700 gpm. Water throughout the aquifer generally contains less than 1,000 mg/l total dissolved solids and is suitable for most purposes.

In the extreme upper part of the Sabine River Basin, the Trinity Group Aquifer contains usable-quality water near its downdip limits. Thickness ranges from 100 to 300 feet. Productive portions of the aquifer occur northwest of the Mexia-Talco fault zone at depths of about 2,700 to 4,000 feet near the fault zone. No wells are known to be producing from this portion of the aquifer. Total dissolved-solids concentrations in ground water in the aquifer in this area range from about 1,000 to 3,000 mg/l. Excessive depth and unknown water quality characteristics may limit development of the aquifer in the Sabine River Basin.

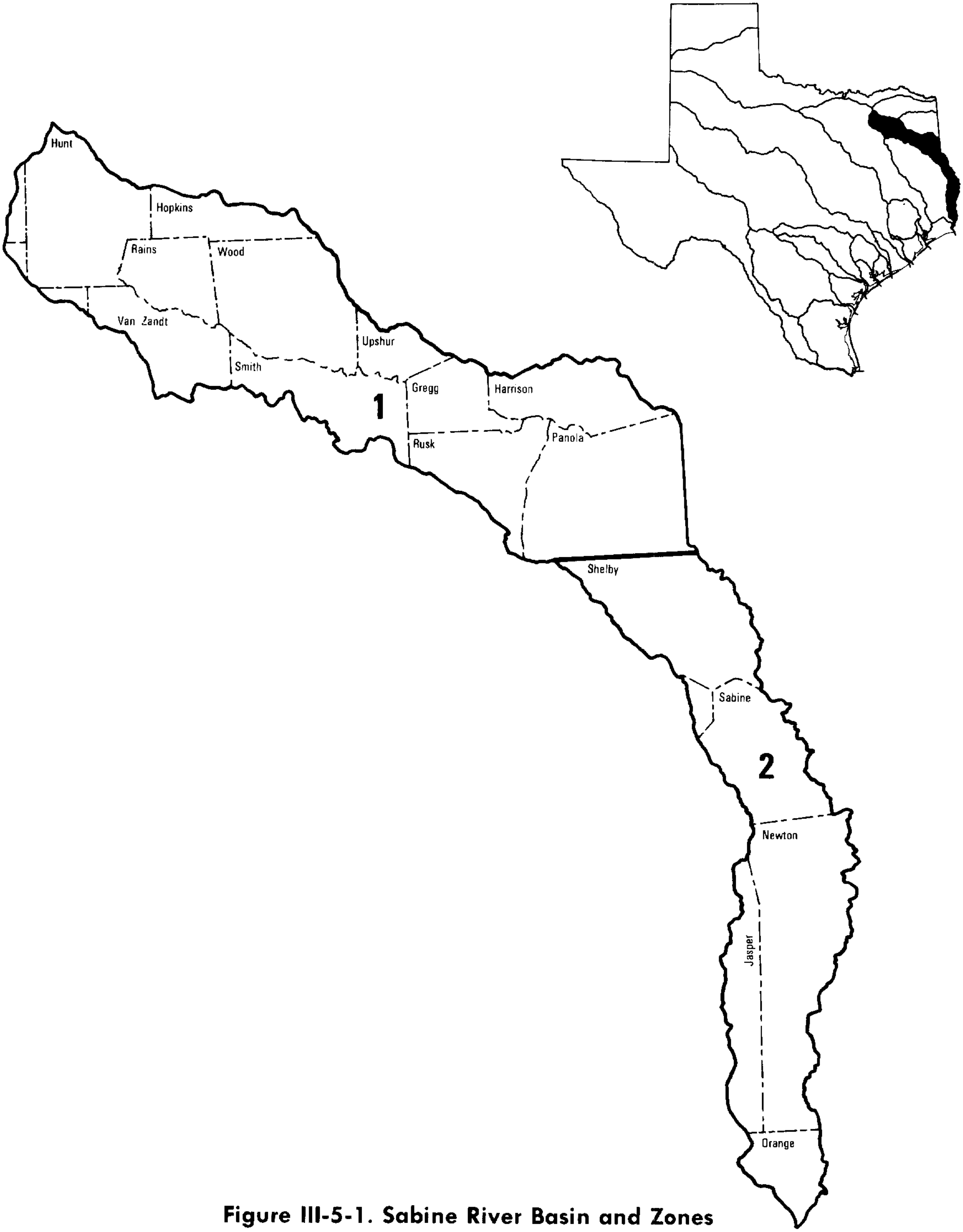


Figure III-5-1. Sabine River Basin and Zones

The Sparta Aquifer occurs in the south-central part of the Sabine River Basin. Limited data suggest that the thickness of the aquifer ranges from 200 to 260 feet. Data on yields of wells in the basin are unavailable; however, in the adjacent Neches River Basin well yields are estimated to average about 200 gpm, but locally wells produce up to 500 gpm. Generally, water produced from the Sparta Aquifer contains less than 500 mg/l total dissolved solids in its outcrop area, but water quality deteriorates rapidly with depth.

The Queen City Aquifer is present in the north-central part of the Sabine River Basin. Thickness ranges from zero to 600 feet. Water-bearing sand comprises 25 to 75 percent of the total thickness of the aquifer. Water in the aquifer is generally under water-table conditions. Well yields range up to 400 gpm. Water produced from the Queen City Aquifer is usually of good quality, having total dissolved-solids concentrations ranging from less than 100 to 300 mg/l.

The Nacatoch Sand Aquifer occurs in the upper part of the Sabine River Basin. Generally, the water-bearing zone occurs in the top 30 to 40 feet of the aquifer; however, its thickness ranges up to 100 to 150 feet downdip from the outcrop. Well yields generally average between 20 to 45 gpm, but may reach 200 gpm. Quality of water produced from the Nacatoch Sand Aquifer ranges from about 800 to 1,350 mg/l total dissolved solids, increasing with depth.

The Woodbine Aquifer occurs in the extreme upper part of the Sabine River Basin. Depths of the aquifer range from 1,600 to 1,800 feet below land surface, and its thickness varies between 550 and 650 feet.

Ground waters contained in the shallow water-bearing sands of the Carrizo-Wilcox and Queen City Aquifers within the basin usually have excessive concentrations of iron and low pH (high acidity) values. Also, due to excessive pumpage, saline-water encroachment may occur from saline water-bearing sands laterally adjacent to or beneath the fresh water-bearing sands of the aquifers.

Population and Economic Development

Population of the Sabine River Basin was reported at 407.3 thousand in 1980. Longview is the largest city in the basin, having a 1980 population of 62,762. It is followed by Marshall, Orange, and Greenville. The economy of the basin is diversified but is based principally on mineral production, agriculture, agribusiness, manufacturing, and recreation and tourism. The Port of Orange serves as a distribution and shipping center for many basin products.

Water Use

Municipal water use in the Sabine River Basin totaled 61.8 thousand acre-feet in 1980. Zone 1 used about 73 percent of total basin municipal water and Zone 2 utilized about 27 percent. Major municipal water- using counties in Zone 1 were Gregg, Harrison, and Hunt. The City of Longview (Gregg County) used 18 percent of total Zone 1 use. In Zone 2, Orange County used over 52 percent of the Zone total.

Water use by manufacturing industries in the Sabine River Basin totaled 84.3 thousand acre-feet in 1980. Upper basin areas (Zone 1) used 45 percent of the total manufacturing requirement, and the lower basin (Zone 2) used 55 percent. Zone 1 water use originated almost entirely in Gregg and Harrison Counties. In Zone 2, water use was concentrated principally in Orange County where large water-using industries of paper and allied products and chemicals are located. These industries used approximately 95 percent, or 43.9 thousand acre-feet, of the total water used in Zone 2 in 1980.

In 1980, there was 4,810 megawatts of steam-electric power generating capacity in the Sabine River Basin. Sixty percent of this capacity was in Zone 1 and used fresh surface water. The remaining 40 percent was located in Zone 2, and used fresh and saline water for cooling. A total of 1.5 thousand acre-feet of ground water was withdrawn for power production purposes. In addition, 23.0 thousand acre-feet of fresh surface water was consumed (including 11.5 thousand acre-feet of estimated net evaporation from cooling reservoirs).

In Zone 1, approximately 600 acre-feet of irrigation water was used in 1980. Irrigable lands in the upper basin are typically located in small, scattered tracts. Generally adequate and evenly distributed rainfall makes irrigation unnecessary most of the time, although supplemental water use is occasionally beneficial on improved pasture, hay, peanuts, some vegetables, and nursery stock. In the rice-growing area of the lower basin (Zone 2), about 8.4 thousand acre-feet of water was used in 1980. Of the total basin irrigation water use of 9.0 thousand acre-feet in 1980, ground water provided negligible amounts.

Mining water use in the Sabine River Basin was estimated at 6.8 thousand acre-feet of freshwater in 1980. Water use was concentrated in Zone 1. Petroleum and natural gas production used 5.2 thousand acre-feet, with the remaining water use being for nonmetals (sulfur and salt).

Livestock water use in 1980 totaled 8.7 thousand acre-feet in the Sabine River Basin. About 7.2 thousand acre-feet was used in Zone 1; Zone 2 used 1.5 thousand acre-feet.

Navigation facilities in the Sabine River Basin include portions of the Sabine-Neches Waterway, the Sabine Pass Channel, the Sabine-Neches Canal, the Sabine River to Orange, the Gulf Intracoastal Waterway, Adams Bayou Channel, and Cow Bayou Channel. These marine navigation facilities have no regulated freshwater requirements.

There is 85 megawatts of hydroelectric power generating capacity in the Sabine River Basin at Toledo Bend Dam, with a design rate of 16,000 cubic feet per second.

Return Flows

In 1980, municipal and manufacturing return flows in the Sabine River Basin totaled 67.0 thousand acre-feet. Zone 2 accounted for 44 percent of total basin return flows (29.5 thousand acre-feet) and the Zone 1 total was 37.5 thousand acre-feet.

Return flows from irrigation in Zone 1 were insignificant in 1980. Return flows from irrigated rice farms totaled about 1.3 thousand acre-feet in Zone 2 in 1980. These return flows enter the river at a point below all diversions and are therefore not reused.

Current Ground-Water Development

In 1980, approximately 54.6 thousand acre-feet of ground water was used in the Sabine River Basin. Of this amount, 30.3 thousand acre-feet was used in Zone 1, and 24.3 thousand acre-feet in Zone 2. In Zone 1 in 1980, about 81 percent of the ground water used was from the Carrizo-Wilcox Aquifer, and about 15 percent was from the Queen City Aquifer. In Zone 2, about 87 percent was used from the Gulf Coast Aquifer, and about 11 percent from the Carrizo-Wilcox Aquifer.

Of the 54.6 thousand acre-feet of ground water used in the basin approximately 42.7 thousand acre-feet or 80 percent was used for municipal and manufacturing purposes.

In 1980 within Zone 2, significant overdraft of ground water from the Carrizo-Wilcox Aquifer for municipal purposes occurred in Smith County. In Zone 2, significant overdrafts of ground water occurred in Orange County from the Gulf Coast Aquifer for municipal and manufacturing purposes, and in Shelby County, from the Carrizo-Wilcox Aquifer for municipal purposes.

Current Surface-Water Development

Since 1954, Texas use of Sabine River Basin water has been subject to the Sabine River Compact.

There are 12 major reservoirs in the Sabine River Basin, 11 of which are located in Zone 1 and one in Zone 2. Existing major reservoirs include Lakes Tawakoni, Holbrook, Hawkins, Quitman, Lake Fork, Winnsboro, Gladewater, Cherokee, Martin, and Murvaul in Zone 1, and Toledo Bend in Zone 2.

Lake Tawakoni and Lake Fork are owned and operated by the Sabine River Authority of Texas. The City of Dallas, located in the upper Trinity River Basin, has contracted with the Sabine River Authority for 80 percent of the water supply in Lake Tawakoni, or approximately 184.5 thousand acre-feet annually. The existing 72-inch diameter pipeline facility from Lake Tawakoni to the Dallas area is capable of delivering about 112 thousand acre-feet of water annually. The City of Dallas presently has under construction an additional 84-inch pipeline from Tawakoni and plans to increase the withdrawal capacity from Tawakoni to 200 million gallons per day. In 1980, 35.9 thousand acre-feet of water was delivered from Lake Tawakoni to Dallas; however, in previous years deliveries have exceeded 50 thousand acre-feet. Additional existing exports from the Sabine River Authority's remaining supply in Lake Tawakoni include deliveries to the City of Commerce in the Sulphur River Basin (933 acre-feet in 1980). The City of Terrell in the Trinity River Basin has also contracted with the Sabine River Authority for supplemental supplies from Lake Tawakoni. Lake Tawakoni also supplies water to Greenville, Wills Point, and other small cities in the Sabine River Basin. Deliveries to these areas totaled about 6.6 thousand acre-feet in 1980.

Lakes Holbrook, Quitman, Hawkins, and Winnsboro are owned and operated by Wood County Fresh Water Supply District and are utilized for recreation and flood-regulation purposes.

Lake Gladewater, owned and operated by the City of Gladewater, provides municipal and manufacturing water supplies for the City of Gladewater and its customers in Gregg and Upshur Counties. Diversions from the reservoir in 1980 totaled 1.2 thousand acre-feet.

Lake Cherokee, owned and operated by the Cherokee Water Company, provides cooling water for Southwestern Electric Power Company's Knox Lee Power Plant located at the reservoir, and municipal and manufacturing water for the Cities of Kilgore, Longview, and White Oak in Gregg County.

Martin Lake, located on Martin Creek in Rusk and Panola Counties, is owned and operated by a consortium of electric power utility companies to provide cooling water and related water needs for four 750 megawatt capacity steam-electric power plant units near the reservoir.

Lake Murvaul, owned by Panola County Fresh Water Supply District, provides municipal and manufacturing water supplies for the City of Carthage and its customers in Panola County.

Lake Fork Reservoir, completed in 1981, is owned by the Sabine River Authority. Provisions of the amended permit issued by the Texas Water Commission allow annual use of 77,940 acre-feet of water for municipal purposes, 70,500 acre-feet for municipal or industrial, and 16,500 acre-feet for industrial purposes.

In addition, the Sabine River Authority, the City of Dallas, and Texas Utilities Generating Company have entered into a Water Supply Contract and Conveyance affecting the 120,000 acre-feet portion of the water covered by this permit, as follows:

1. The City of Dallas would be entitled to 74 percent of the yield from Lake Fork Reservoir, not to exceed 120,000 acre-feet per year, reduced by the amount that Phillips Coal Company (30,000 acre-feet per year maximum), Tenneco Coal Company (20,000 acre-feet per year maximum), and Texas Utilities Generating Company (17,000 acre-feet per year maximum as set forth in paragraph No. 2 below) decide to take.

2. The City of Dallas gives Texas Utilities Generating Company an option to purchase up to 17,000 acre-feet of water annually out of its 120,000 acre-feet, which option must be exercised prior to September 1, 1994.

3. In the event either Phillips or Tenneco fail to take all of the water to which each is entitled under their respective agreements with the Sabine River Authority, then the Authority has the right to sell up to an additional 10,000 acre-feet out of the City of Dallas' 120,000 acre-feet.

4. The term of this Contract runs from October 1, 1981, until November 1, 2014, and it is to be renewed for additional terms of 40 years unless the City of Dallas terminates its option to renew.

The Sabine River Authority has also agreed to enter into a Water Purchase Agreement with Texas Utilities Generating Company to sell 20,000 acre-feet of water annually in addition to the amount to be sold to the City of Dallas. Out of this amount, Texas Utilities Generating Company will release 3,500 acre-feet of water annually upon request by the Authority to be sold for municipal use.

The Sabine River Authority has been granted changes to the permit contemplated as a result of the contracts. These include a request for authorization to transfer as much as 120,000 acre-feet of water per year from Lake Fork in the Sabine River Basin to the Trinity River Basin.

Within Zone 1, water is also diverted from the main stem of the Sabine River under existing permits. Major diversions occur in Gregg and Harrison Counties, principally for manufacturing use.

In Zone 2, Toledo Bend Reservoir, owned jointly by the Sabine River Authorities of Texas and Louisiana, is the fifth largest reservoir in the United States with a total capacity of 4.477 million acre-feet. The project, completed in 1968, is operated jointly by the two river Authorities in accordance with terms of the Sabine River Compact between Texas and Louisiana. Toledo Bend Reservoir provides water for municipal, manufacturing, irrigation, hydroelectric power generation, and recreation purposes. The existing permit issued to the Sabine River Authority of Texas by the Texas Water Rights Commission provides for use of 100 thousand, 600 thousand, and 50 thousand acre-feet annually for municipal, industrial, and irrigation purposes, respectively. At the present time, the only cities obtaining municipal supplies from the reservoir are Hemphill, in Sabine County and Huxley, in Shelby County. In addition, several private water companies have contracted with the Authority for water from the reservoir.

In accordance with a contract between the two Authorities and several utility companies in both Louisiana and Texas, the Authorities are compensated by the payment of an aggregate sum of money each year for hydroelectric power generated through releases of water through the dam between elevations 172.0 and 162.2 mean sea level (top of power head storage). Subject to the availability of water in storage, releases are made through the two turbines sufficient to produce at least 65.7 million kilowatt hours of electricity during the period May to September each year.

Below Toledo Bend Reservoir, the Sabine River branches, and part of the river flow enters Old River, in Louisiana, through Cutoff Bayou. Privately owned companies in Louisiana periodically divert these flows through the Krause and Managon Canal and Sabine Canal Systems for rice irrigation. Several miles downstream from Cutoff Bayou, part of the flow of the river enters Indian Bayou in Texas. The Sabine River Authority of Texas periodically diverts these flows through its diversion channel westward for irrigation and manufacturing uses. In 1980, approximately 35.5 thousand acre-feet of water was diverted through this system and used by manufacturing plants in the Orange area under contracts with the Sabine River Authority of Texas. In addition, 3.6 thousand acre-feet was supplied through the system in the Orange area for cooling water in steam-electric power generation.

During periods of low flow, saline water from the Gulf and Sabine Lake intrudes significant distances upstream into both the Sabine and Old Rivers such that diversion facilities are negatively affected, especially by Louisiana diverters. However, this has not been a problem since Toledo Bend Reservoir became operational in 1968.

Water Rights

A total of 1,671,505 acre-feet of surface water was authorized or claimed for diversion and use in the Sabine River Basin as of December 31, 1983 (Table III-5-1). Municipal use accounted for 37.4 percent of the total amount of water authorized and/or claimed in the basin (Table III-5-2). Zone 2 accounted for the greater portion of authorized or claimed water use, with 902,338 acre-feet or 54.0 percent of the total.

Table III-5-1. Authorized or Claimed Amount of Water, by Type of Right, Sabine River Basin[1]

Type of Authorization	Number of Rights	Acre-Feet Authorized and Claimed
Permits	116	1,648,076
Claims	190	23,429
Certified Filings	0	0
Certificates of Adjudication	0	0
Total Authorizations and Claims	306	1,671,505

[1]The Texas Water Rights Adjudication Act of 1967 authorizes the Texas Department of Water Resources to investigate and determine, with the Court's approval, the nature and measure of water rights for all authorized diversions from surface-water streams or portions thereof except domestic and livestock uses and to monitor and administer each adjudicated water right. These totals incorporate the results of water-rights adjudication in the basin as of December 31, 1983. Certified Filings are declarations of appropriation which were filed with the State Board of Water Engineers under the provisions of Section 14, Chapter 171, General Laws, Acts of the 33rd Legislature, 1913, as amended. Permits are statutory appropriative rights which have been issued by the Texas Water Commission or its predecessor agencies. Claims are sworn statements of historical uses to be adjudicated in accordance with the Texas Water Rights Adjudication Act. A certificate of adjudication is the final result after recognition of a valid right in the adjudication process and is based on a permit, certified filing or claim or any combination of the three.

Table III-5-2. Authorized or Claimed Amount of Water, by Type of Use and Zone, in Acre-Feet, Sabine River Basin

Type of Use	Number of Rights	Zone 1	Zone 2	Total
Municipal	31	492,885	131,460	624,345
Industrial[2]	25	199,329	671,735	871,064
Irrigation	173	15,246	98,868	114,294
Mining	3	951	0	951
Recreation	82	60,576	275	60,851
Other	1	0	0	0
Total	306[1]	769,167	902,338	1,671,505

[1]Does not sum due to multipurpose "rights", which may be applied to more than one type of use.
[2]Does not include an authorized diversion of saline water in Zone 2 in the amount of 360,000 acre-feet/year.

Water Quality

The Sabine River below the Longview area and the Adams Bayou have experienced periodic dissolved-oxygen depressions and recurrent fish kills attributable primarily to discharge of treated municipal and industrial effluents. However, improved waste treatment in the past few years has improved the water quality. The tidally affected areas of the basin, particularly in the area of Adams and Cow Bayous, are experiencing rapid increases in population and industrial growth resulting in high volumes of treated industrial wastewaters.

Flooding, Drainage, and Subsidence

According to the U.S. Army Corps of Engineers, the Sabine River Basin has incurred damages from major flooding 11 times since 1957. Damages from Hurricane Carla in 1961 were not as substantial to Orange County as they were in other coastal counties. However, damages totaled over $750 thousand, mostly nonagricultural. The most costly flood occurred in 1974 when agriculture losses amounted to $582.2 thousand and nonagricultural damages amounted to $2.64 million. Major floods in 1979 and 1980 in the lower basin produced major damages in Orange County and Bridge City. During the period 1978-1981, 203 flood insurance claims were filed for $869 thousand in flood damages. Floods in April 1979 and Tropical Storm Claudette in July 1979 resulted in two Presidential disaster declarations with the expenditure of slightly over $1.2 million in disaster relief by various federal agencies.

The Federal Emergency Management Agency has designated 49 cities in the Sabine River Basin as having one or more special flood-hazard areas. Currently, 27 of these cities are participating in the National Flood Insurance Program. Flood insurance rate studies have been completed for the Cities of Gladewater, Kilgore, Longview, Marshall, Greenville and 100-year base flood elevations are available. The incorporated cities within Orange County are currently being studied to determine 100-year flood elevations.

In the upper Sabine River Basin, drainage problems occur in the river bottomlands and adjoining terraces above Toledo Bend Reservoir. On-farm drainage improvements and lateral ditching can abate most of the problems. Drainage problems in the lower basin are more complex and require substantial improvements to achieve proper drainage, particularly where large quantities of irrigation water are used to flood rice farms. Accumulations of surface water from intense storm activity associated with hurricanes or tropical storms compound drainage problems in the lower basin.

Land subsidence due to compaction of clays caused by ground-water withdrawals and oil production is a potential problem in southern Newton, southern Jasper, and eastern Orange Counties within the Sabine River Basin. Also, fault activation and movement which can cause considerable damage to property are associated with subsidence. Damages caused by fault movement are very evident in urban areas of the Gulf Coastal Plain. Subsidence and fault movement also are caused locally by extractions of sulfur and other minerals in the Gulf Coastal Plain.

Recreation Resources

Sixteen percent of the total surface area of all reservoirs (5.0 thousand acre-feet capacity or more) in the State is located in the Sabine River Basin. The Sabine River Basin is exceeded only by the Trinity River Basin in total number of reservoir surface acres available for water-oriented recreation activities. Toledo Bend Reservoir in Zone 2 of the basin, with 181.6 thousand surface acres, is the largest lake in the State in terms of surface area. It is the only major reservoir in Zone 2, but accounts for over 75 percent of the basin's total reservoir surface area. Toledo Bend Reservoir offers excellent black bass, crappie, and white bass fishing. There are also many facilities for picnicking and camping. Lake Tawakoni (36.7 thousand surface acres) is the largest of the nine fresh water impoundments in Zone 1, providing approximately 63 percent of the available water-oriented recreation resources in the Zone.

PROJECTED WATER REQUIREMENTS

Population Growth

The population of the Sabine River Basin is projected to increase by 97 percent between 1980 and 2030 (Table III-5-3). By 2000, the population is expected to grow by 37 percent; from 2000 to 2030, a 45 percent increase is projected.

Gregg County (including the Cities of Gladewater, Kilgore, and Longview) is the most populous county in the basin with 24 percent of the basin's total population in 1980. By 2030, a projected increase in population of 91 percent is expected. Orange County population was 14 percent of the basin total in 1980 and is expected to remain at 14 percent in 2030.

Water Requirements

Municipal

Municipal water requirements are projected for two cases of future growth based on both population and per capita water use. Municipal water requirements in the Sabine River Basin are estimated to increase from 23 to 88 percent by the year 2000 over the 1980 level of 61.8 thousand acre-feet. By 2030, municipal water requirements are expected to range from 102.8 to 167.6 thousand acre-feet. Seventy-five percent of the projected basin requirements in 2000 and 76 percent in 2030 is located in Zone 1.

Industrial

Manufacturing water requirements in 1980 were 84.3 thousand acre-feet in the Sabine River Basin. Projections of future water requirements for manufacturing purposes were made by decade and for a low and high case for each industrial group. In 1980, over 90 percent of total manufacturing water use was concentrated in five industrial groups: chemicals, petroleum refining, primary metals, paper products, and food products. Because of this concentration, careful attention was given to the future growth outlook for these industries in making the projections.

Manufacturing water requirements in the Sabine River Basin are projected to increase more than fourfold by the year 2030 from the 1980 level. In 1980, Zone 2 of the

Table III-5-3. Population, Current Water Use, With Projected Population and Water Requirements, 1990-2030a/
Sabine River Basin

River Basin Zone & Category of Use	1980 Ground Water	1980 Surface Water	1980 Total	1990 Ground Water	1990 Surface Water	1990 Total	2000 Ground Water	2000 Surface Water	2000 Total	2010 Ground Water	2010 Surface Water	2010 Total	2020 Ground Water	2020 Surface Water	2020 Total	2030 Ground Water	2030 Surface Water	2030 Total
Zone 1																		
Population			296.8			364.5			416.4			468.6			535.9			609.2
Municipal	18.9	26.2	45.1	11.2	63.2	74.4	11.7	75.3	87.0	12.1	85.9	98.0	12.9	99.1	112.0	14.2	113.0	127.2
Manufacturing	1.9	35.9	37.8	0.3	60.5	61.8	1.3	86.5	87.8	1.3	117.3	118.6	1.3	151.4	152.7	1.3	195.0	196.3
Steam Electric	0.0	17.5	17.5	0.0	39.5	39.5	0.0	48.4	48.4	11.2	58.3	69.5	7.1	75.8	82.9	6.9	93.2	100.1
Mining	6.3	0.5	6.8	6.4	0.2	6.6	6.1	16.4	22.5	5.5	24.8	30.3	4.8	33.2	38.0	4.1	25.6	29.7
Irrigation	0.1	0.5	0.6	0.2	0.4	0.6	0.2	0.5	0.7	0.2	0.5	0.7	0.2	0.5	0.7	0.2	0.5	0.7
Livestock	3.1	4.1	7.2	1.5	7.0	8.5	1.5	8.4	9.9	1.5	8.4	9.9	1.5	8.4	9.9	1.3	8.6	9.9
Zone Total Water	30.3	84.7	115.0	20.6	170.8	191.4	20.8	235.5	256.3	31.8	295.2	327.0	27.8	368.4	396.2	28.0	435.9	463.9
Zone 2																		
Population			110.5			126.6			139.8			153.9			171.6			194.7
Municipal	14.3	2.4	16.7	15.5	10.2	25.7	17.4	11.7	29.1	18.1	13.9	32.0	18.8	16.8	35.6	19.8	20.6	40.4
Manufacturing	7.6	38.9	46.5	14.5	71.7	86.2	14.5	100.1	114.6	14.5	126.8	141.3	14.5	157.8	172.3	14.5	195.1	209.6
Steam Electric	1.5	5.5	7.0	0.0	7.0	7.0	0.0	8.8	8.8	0.0	19.3	19.3	0.0	37.5	37.5	0.0	51.9	51.9
Mining	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Irrigation	0.0	8.4	8.4	0.0	3.3	3.3	0.0	3.3	3.3	0.0	3.3	3.3	0.0	3.3	3.3	0.0	3.3	3.3
Livestock	0.9	0.6	1.5	1.2	0.6	1.8	1.2	0.9	2.1	1.3	0.8	2.1	1.3	0.8	2.1	1.2	0.9	2.1
Zone Total Water	24.3	55.8	80.1	31.2	92.8	124.0	33.1	124.8	157.9	33.9	164.1	198.0	34.6	216.2	250.8	35.5	271.8	307.3
BASIN TOTALS																		
Population			407.3			491.1			556.2			622.5			707.5			803.9
Municipal	33.2	28.6	61.8	26.7	73.4	100.1	29.1	87.0	116.1	30.2	99.8	130.0	31.7	115.9	147.6	34.0	133.6	167.6
Manufacturing	9.5	74.8	84.3	15.8	132.2	148.0	15.8	186.6	202.4	15.8	244.1	259.9	15.8	309.2	325.0	15.8	390.1	405.9
Steam Electric	1.5	23.0	24.5	0.0	46.5	46.5	0.0	57.2	57.2	11.2	77.6	88.8	7.1	113.3	120.4	6.9	145.1	152.0
Mining	6.3	0.5	6.8	6.4	0.2	6.6	6.1	16.4	22.5	5.5	24.8	30.3	4.8	33.2	38.0	4.1	25.6	29.7
Irrigation	0.1	8.9	9.0	0.2	3.7	3.9	0.2	3.8	4.0	0.2	3.8	4.0	0.2	3.8	4.0	0.2	3.8	4.0
Livestock	4.0	4.7	8.7	2.7	7.6	10.3	2.7	9.3	12.0	2.8	9.2	12.0	2.8	9.2	12.0	2.5	9.5	12.0
Basin Total Water	54.6	140.5	195.1	51.8	263.6	315.4	53.9	360.3	414.2	65.7	459.3	525.0	62.4	584.6	647.0	63.5	707.7	771.2

a/ Population in thousands of persons, water requirements in thousands of acre-feet per year.

basin accounted for 55 percent of the total industrial water use; by 2030, 52 percent of the projected water need is in Zone 2. Orange County accounted for most of the Zone 2 requirement in 1980 and is anticipated to continue to dominate water use in 2030. Major water-using industries in Orange County include industrial organic chemicals, plastic materials, synthetics, paperboard mills, and petroleum refineries.

In Zone 1 of the Sabine River Basin, Harrison County accounts for the majority of the 1980 manufacturing water requirements.

Steam-Electric Power Generation

Large near-surface lignite deposits and available water supplies are supporting growth of steam-electric power generating capacity in the Sabine River Basin. Additional growth of plant capacity in the coastal area, using fresh and saline water for cooling, is also projected to occur. In 1980, 24.5 thousand acre-feet of water was consumed for steam-electric power generation, with 71 percent occurring in Zone 1. Future growth was projected for two demand cases for electricity. Water requirements are projected to range from 55.4 to 57.2 thousand acre-feet by 2000; and increase from 98 to 161 percent by 2030 (low and high case, respectively).

Agriculture

Irrigation

Irrigation water requirements were projected for two cases of change based on improvements in on-farm application efficiencies, reduction in ditch losses, changes in future resource costs and crop prices, and corresponding changes in cropping patterns to reflect more profitable crops. A low case projects demand for water based on the effects of changes in the above variables but with irrigated acreage held constant at 1980 levels in each zone for each future time period; a high case projects demand for water for irrigation constrained only by the requirement that irrigated farming produce a net positive return in excess of that possible from dryland farming and the requirement not to exceed the amount of irrigable soil in each zone. Thus, the projections of demand, low and high cases, based on the irrigation efficiency and market conditions mentioned above, give an estimate of the quantity of water needed for irrigation in each zone, at each decadal point for which projections were made. These projections of demand are compared to the projected supply of water locally available. When projected demand exceeds projected supply, the difference is a measure of shortage at that point in time.

Irrigation water requirements in the Sabine River basin are projected to decrease from the 1980 level of 9.0 thousand acre-feet by a projected maximum 56 percent by the year 2000 in the high and the low case. In the year 2030, water requirements in the Basin are projected to be about 4.0 thousand acre-feet annually, in both the low and high case, respectively, to irrigate about 2.0 thousand acres.

Zone 2 is projected to account for about 83 percent of total basin irrigation requirements in 2000 and 2030. Zone 1 is projected to account for about 17 percent of the total.

Livestock

A projected increase in livestock production in the Sabine River Basin would increase livestock water needs. It is estimated that annual livestock water requirements will increase from 8.7 thousand acre-feet in 1980 to 12 thousand acre-feet by 2030. Livestock water use in Zone 1 is expected to increase from 7.2 thousand acre-feet in 1980 to 9.9 thousand acre-feet in 2030. Livestock water needs on Zone 2 are projected to expand from 1.5 thousand acre-feet in 1980 to 2.1 thousand acre-feet by 2030.

Mining

Total mining water requirements in the Sabine River Basin are projected to increase significantly during the planning period primarily from the production of Frasch sulfur and synfuels. In 1980, mining water requirements were 6.8 thousand acre-feet, with use concentrated in Zone 1. By 2000, water requirements are projected to increase 231 percent mostly due to the production of synfuels. From 2000 to 2030, water use estimates are projected to increase another 32 percent to 29.7 thousand acre-feet.

Navigation

If a last downstream lock is maintained at river mile 19.4 north of Orange, then freshwater requirements are projected to be 18.5 thousand acre-feet in 2000, and 20.8 thousand acre-feet in 2030.

Hydroelectric Power

There are currently no plans or federal authorizations to expand the existing 85 megawatts of installed hydroelectric capacity in the Sabine River Basin. With the construction of additional reservoirs, water needs for hydroelectric power could increase.

Estuarine Freshwater Inflows

The Sabine River, along with the Neches River, discharges into the Sabine-Neches estuary. Estimates of freshwater inflow needs for the Sabine-Neches estuary are based on the total flow from both river basins.

The Subsistence Alternative estimate of gaged river inflows necessary to sustain monthly salinities within a range of desirable salinities and maintain historical marsh inundation frequency totals about 5.69 million acre-feet annually (Table III-5-4). The annual inflow from ungaged portions of the Sabine and Neches River Basins is estimated at 1.83 million acre-feet. The Biotic Species Viability Alternative estimate of gaged river inflows necessary to maintain the short-term (monthly) upper viability limits for salinity in the Sabine-Neches estuarine system totals about 2.02 million acre-feet per year (Table III-5-4).

Table III-5-4. Gaged River Inflow Needs of the Sabine-Neches Estuary Under Two Alternative Levels of Fisheries Production[1]

Month	Ecosystem Subsistence	Biotic Species Viability
January	350.7	211.0
February	361.7	212.1
March	340.4	215.1
April	535.4	253.0
May	1,282.3	228.6
June	477.5	186.1
July	204.3	89.7
August	178.5	76.5
September	132.2	130.2
October	1,282.3	134.9
November	189.1	107.1
December	352.0	175.8
Annual	5,686.4	2,020.1

[1]Combined gaged streamflow of Sabine River near Ruliff and Neches River at Evadale in thousand acre-feet.

The freshwater inflow needs for the two additional Alternatives (Fisheries Harvest Maintenance and Fisheries Harvest Enhancement) could not be evaluated for this estuary because the fisheries harvest equations derived for this estuary were not valid for the range of possible flows. If the freshwater inflows were consistently limited to those estimated by the Subsistence Alternative, the salinity regime of Sabine Lake would shift from the existing low salinity regime to a more truly estuarine environment. This change in the salinity regime could increase the species diversity and productivity in Sabine Lake, presuming an absence of toxic materials and assuming that existing marsh habitats are maintained. However, the quantity and quality of possible changes in the estuary cannot be accurately assessed from existing data which reflect only past conditions in the estuary. The Sabine-Neches estuary is the only estuary, of six estuaries studied, for which it was not possible to compute estimates of freshwater inflow needs for all four of the Alternatives.

WATER SUPPLY PROJECTS AND MEASURES TO MEET FUTURE BASIN NEEDS

Ground-Water Availability and Proposed Development

The approximate annual ground-water yield within the Sabine River Basin to the year 2030 is 244.8 thousand acre-feet with the following amounts annually available by aquifer: 54.0 thousand acre-feet from the Gulf Coast Aquifer, 45.2 thousand acre-feet from the Carrizo-Wilcox Aquifer, 7.4 thousand acre-feet from the Sparta Aquifer, 0.4 thousand acre-feet from the Trinity Group Aquifer, and 137.8 thousand acre-feet from the Queen City Aquifer. Since the ground water available from the Queen City Aquifer within the basin has high concentrations of iron and high acidity (low pH), it should not be considered a suitable source of water for municipal and most manufacturing purposes. However, Queen City ground water is suitable for irrigation, steam-electric power generation (cooling), mining and livestock-watering purposes. At the end of the year 2029, the annual yield of the Trinity Group Aquifer within the basin would be reduced from 0.4 thousand acre-feet to zero, because all of the ground water in recoverable artesian storage would have been removed. Since the artesian portion of the Trinity Group Aquifer within the basin does not receive any effective recharge, the yield of the aquifer in the year 2030 would be zero. In the year 2030, the yield of the Carrizo-Wilcox Aquifer within the basin would be reduced to the aquifer's average annual effective recharge of 44.0 thousand acre-feet per year. These reductions decrease the total ground-water availability within the basin in 2030 to 243.2 thousand acre-feet.

The projected annual ground-water use within the Sabine River Basin by decade from 1990 through 2030 is expected to be from 51.8 to 65.7 thousand acre-feet per year (Table III-5-3). The approximate average annual projected ground-water use within the basin is expected to be about 59.5 thousand acre-feet per year. Of the 59.5 thousand acre-feet of average annual projected use, about 54 percent is expected to be from the Gulf Coast Aquifer, about 43 percent from the Carrizo-Wilcox Aquifer, and about 3 percent from the Queen City Aquifer.

Surface-Water Availability and Proposed Development

Projected surface-water needs in the Sabine River Basin can be fully met from existing and potential reservoirs through the year 2030 (Table III-5-5, Figure III-5-2). Currently available surface-water resources in the Sabine River Basin are sufficient to meet all projected surface-water needs within the basin through the year 2030, except in Zone 1.

Zone 1

Surface-water resources, existing and proposed, are estimated to exceed surface-water requirements in Zone 1, including water export needs to adjacent river basins, by about 36.2 thousand acre-feet in the year 2030 (Table III-5-6, Figure III-5-3). Approximately 301.8 thousand acre-feet of the year 2030 total water requirements in this Zone is estimated for export, principally to the upper Trinity River Basin. In that same year, approximately 59.1 thousand acre-feet is projected for import, primarily from the Toledo Bend Reservoir in Zone 2 of the Basin, to meet water needs in this Zone.

Water needs in Zone 1 may be met through the development by the year 1990 of the Big Sandy Reservoir project in the Sabine River Basin, although it is highly unlikely that the project can be constructed by that time. The Big Sandy Reservoir project, authorized by Congress in 1970, will be located on Big Sandy Creek in Wood County, with the dam located about 13 miles upstream above the confluence of Big Sandy Creek and the Sabine River. Additional studies of the project are currently underway by the U.S. Bureau of Reclamation and are likely to result in modifications to the authorized project. The authorized project would provide a dependable yield of 76.9 thousand acre-feet annually. Water from the project is proposed to be used by 1990 to supply the Marshall and Kilgore areas with municipal and manufacturing water.

Between 2020 and 2030, additional surface water will be needed in the Marshall area. Water pumped by pipeline from Toledo Bend Reservoir in Zone 2 of the basin is proposed to meet the needs. Additional studies will have to be performed by the Department and regional interests to examine the engineering alternatives and the economic, environmental, and institutional considerations that would be involved in such a major intrabasin transfer of water.

The City of Longview is currently studying the proposed Prairie Creek Reservoir on Prairie Creek in Gregg and Smith Counties. The project is estimated to supply a yield of 40.0 thousand acre-feet annually with approximately 30.0 thousand acre-feet of this yield supplied as a result of direct diversion of water from the Sabine River. For planning purposes, this reservoir is proposed to be constructed by 2000 to meet the additional future water needs of the City of Longview.

The City of Dallas has contracted with the Sabine River Authority for 53.0 thousand acre-feet of firm annual supply from Lake Fork. By 2000, Dallas will need this supply to meet future needs and will have to construct pumping and pipeline facilities to convey this water.

By the year 2020, steam-electric power requirements in the upper Sabine River Basin are projected to exceed available supplies necessitating the development of additional water resources to avoid shortages. An alternative to meet this need and provide water for export to the upper Trinity River Basin for the City of Dallas is the Carl Estes Reservoir on the Sabine River below Lake Tawakoni. Pipeline facilities would be required to convey water to the City of Dallas through Lake Tawakoni.

The authorized Carl L. Estes Reservoir project has undergone advanced engineering and design studies by the Corps of Engineers. The Corps determined that the project was not a currently feasible federal project in part due to extensive shallow lignite beds under the reservoir site. The Corps estimates that the lignite could be mined by 2020 thereby allowing construction of the project before 2020.

Considerable study has also been given to the feasibility of the Carthage Reservoir project, which would be located in Zone 1. This project could be on the main stem of the Sabine River above Toledo Bend Reservoir at about river mile 321. Additional studies are needed to determine the firm water supply available from this project.

Zone 2

Total surface-water supplies are projected to exceed in-basin and export water demands in Zone 2 of the Sabine River Basin by 499.9 thousand acre-feet in the year 2030 under existing and proposed surface-water development (Table III-5-7, Figure III-5-4). The surface-water requirements for this zone in 2030 are estimated at approximately 1.27 million acre-feet, with about 961.7 thousand acre-feet projected to be exported from this zone to other basins in the year 2030. This water is projected as the supply for import into the Houston-Galveston area to meet projected municipal and manufacturing water needs.

Zone 2 of the Sabine River Basin will continue to have substantial supplies of surface water surplus to projected in-basin needs. Except during recurrences of critical drought period, surpluses in excess of both in-basin needs

Table III-5-5. Water Resources of the Sabine River Basin, With Projected Water Supplies and Demands, 1990-2030[1]

Decade	Water Supply: In Basin	Water Supply: Intra-Basin	Water Supply: Return Flow	Water Supply: Import	Water Supply: Total	Water Demand: In Basin	Water Demand: Intra-Basin	Water Demand: Export	Water Demand: Total	Surplus or Shortage: M & I	Surplus or Shortage: Irrigation (Shortage)	Surplus or Shortage: Total
1990												
Ground Water	51.8	—	—	—	51.8	51.8	—	—	51.8	.0	.0	.0
Surface Water	1762.3	—	62.0	19.3	1843.6	226.1	—	141.8	367.9	1475.7	.0	1475.7
Total	1814.1	—	62.0	19.3	1895.4	277.9	—	141.8	419.7	1475.7	.0	1475.7
2000												
Ground Water	53.9	—	—	—	53.9	53.9	—	—	53.9	.0	.0	.0
Surface Water	1802.3	—	78.1	19.7	1900.1	321.0	—	251.6	572.6	1327.5	.0	1327.5
Total	1856.2	—	78.1	19.7	1954.0	374.9	—	251.6	626.5	1327.5	.0	1327.5
2010												
Ground Water	65.7	—	—	—	65.7	65.7	—	—	65.7	.0	.0	.0
Surface Water	1814.5	—	95.2	19.5	1929.2	420.1	—	615.4	1035.5	893.7	.0	893.7
Total	1880.2	—	95.2	19.5	1994.9	485.8	—	615.4	1101.2	893.7	.0	893.7
2020												
Ground Water	62.4	—	—	—	62.4	62.4	—	—	62.4	.0	.0	.0
Surface Water	1905.8	—	114.5	19.3	2039.6	545.3	—	655.6	1200.9	838.7	.0	838.7
Total	1968.2	—	114.5	19.3	2102.0	607.7	—	655.6	1263.3	838.7	.0	838.7
2030												
Ground Water	63.5	—	—	—	63.5	63.5	—	—	63.5	.0	.0	.0
Surface Water	2279.5	—	168.1	20.1	2467.7	668.1	—	1263.5	1931.6	536.1	.0	536.1
Total	2343.0	—	168.1	20.1	2531.2	731.6	—	1263.5	1995.1	536.1	.0	536.1

[1] Units in thousands of acre-feet per year. Water demands are for the "high" case. Tabulated surface water demands do not include livestock needs, some quantities of irrigation needs and other needs which will continue to be met from local, unregulated surface-face supplies.

Definitions

Intra-Basin: A transfer of water among zones within a river basin.

Import: A transfer of water from another river basin.

Return Flows: Wastewater returned to a natural stream channel that can be recaptured at a downstream point.

Export: A transfer of water to another river basin.

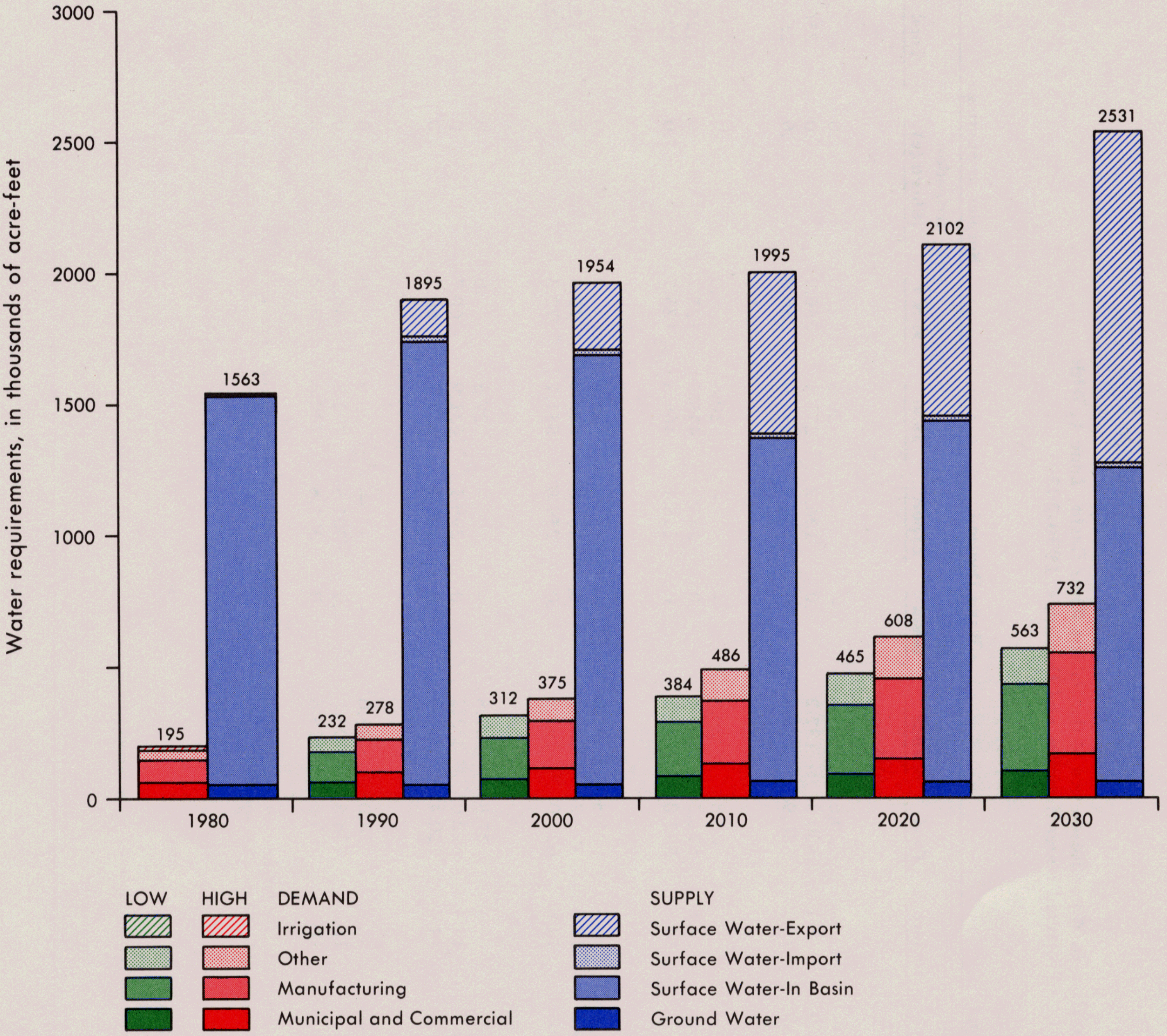


Figure III-5-2. Reported Use and Supply Source, With Projected Water Supplies and Demands, Sabine River Basin, 1980-2030

and freshwater requirements of the Sabine Lake estuarine system will be available for conveyance to water-deficient areas provided appropriate institutional arrangements can be made. Studies performed by and for the Department indicate that it is physically feasible to convey relatively large quantities of water from the lower Sabine River to the Trinity River Basin in order to meet the severe water shortages projected to occur in the San Jacinto River Basin and contiguous areas in the coastal area beyond the year 2000.

Existing surface-water resources in the Brazos and San Jacinto River Basins and San Jacinto-Brazos and Brazos-Colorado Coastal Basins are estimated to be insufficient to satisfy projected surface-water needs in these basins. Water supplies from Toledo Bend Reservoir, that are surplus to the projected Sabine River Basin needs could be diverted through a gravity flow and pumping conveyance system to the Houston metropolitan area and lower Brazos River Basin (Zone 6) and adjacent coastal basins to

Table III-5-6. Water Resources of the Sabine River Basin, Zone 1, With Projected Water Supplies and Demands, 1990-2030[1]

	Water Supply					Water Demand				Surplus or Shortage		
Decade	In Zone	Intra-Basin	Return Flow	Import	Total	In Zone	Intra-Basin	Export	Total	M & I	Irrigation (Shortage)	Total
1990												
Ground Water	20.6	—	—	—	20.6	20.6	—	—	20.6	.0	.0	.0
Surface Water	508.3	.0	6.9	15.1	530.3	137.2	.0	136.2	273.4	256.9	.0	256.9
Total	528.9	.0	6.9	15.1	550.9	157.8	.0	136.2	294.0	256.9	.0	256.9
2000												
Ground Water	20.8	—	—	—	20.8	20.8	—	—	20.8	.0	.0	.0
Surface Water	548.3	.0	8.1	14.8	571.2	200.4	.0	245.1	445.5	125.7	.0	125.7
Total	569.1	.0	8.1	14.8	592.0	221.2	.0	245.1	466.3	125.7	.0	125.7
2010												
Ground Water	31.8	—	—	—	31.8	31.8	—	—	31.8	.0	.0	.0
Surface Water	568.3	.0	9.3	14.6	592.2	260.1	.0	259.8	519.9	72.3	.0	72.3
Total	600.1	.0	9.3	14.6	624.0	291.9	.0	259.8	551.7	72.3	.0	72.3
2020												
Ground Water	27.8	—	—	—	27.8	27.8	—	—	27.8	.0	.0	.0
Surface Water	667.5	.0	10.7	14.4	692.6	333.2	.0	298.7	631.9	60.7	.0	60.7
Total	695.3	.0	10.7	14.4	720.4	361.0	.0	298.7	659.7	60.7	.0	60.7
2030												
Ground Water	28.0	—	—	—	28.0	28.0	—	—	28.0	.0	.0	.0
Surface Water	667.5	43.9	11.9	15.2	738.5	400.5	.0	301.8	702.3	36.2	.0	36.2
Total	695.5	43.9	11.9	15.2	766.5	428.5	.0	301.8	730.3	36.2	.0	36.2

[1] Units in thousands of acre-feet per year. Water demands are for the "high" case. Tabulated surface water demands do not include livestock needs, some quantities of irrigation needs and other needs which will continue to be met from local, unregulated surface-face supplies.

Definitions
Intra-Basin: A transfer of water among zones within a river basin.
Import: A transfer of water from another river basin.
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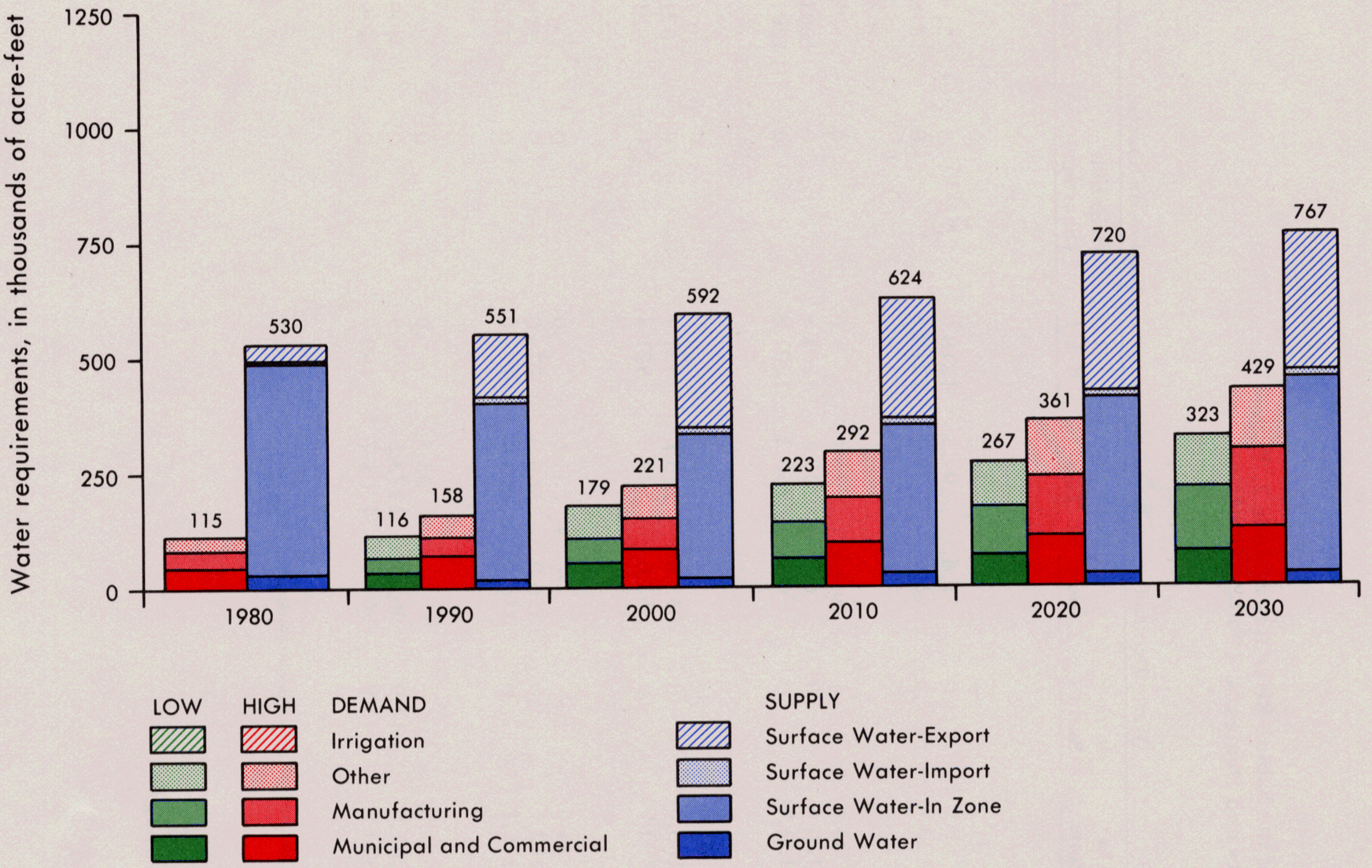

Figure III-5-3. Reported Use and Supply Source, With Projected Water Supplies and Demands, Sabine River Basin, Zone 1, 1980-2030

meet these anticipated shortages. Water from Zone 2 of the Sabine River Basin could be needed by year 2010. Anticipated increases in water needs in the Houston area that could be met from the Sabine River Basin are projected to exceed the available surface water from Toledo Bend Reservoir between 2020 and 2030.

The potential Bon Wier Reservoir project, studied by the Corps of Engineers and included in the Report of Sabine River Basin Comprehensive Study, would provide additional water supply, recreation, and possibly hydroelectric power generation in the lower Sabine River Basin. The project, with the dam site tentatively located at river mile 102, would also provide re-regulation of hydroelectric power generation releases from Toledo Bend Dam. Based on preliminary design criteria, without flood control as a project purpose Bon Wier Reservoir would have a conservation storage of 339.8 thousand acre-feet, 23 thousand acre-feet of sediment storage, and a dependable yield of about 441.5 thousand acre-feet annually. With 124.5 thousand acre-feet of storage capacity allocated to flood control and/or re-regulation of power releases from Toledo Bend Dam, the alternative project would have a dependable yield of approximately 381.5 thousand acre-feet. Additional surface water for the Houston area could be developed by the construction of the Bon Weir Reservoir project by year 2030.

Additional studies will have to be performed by the Texas Department of Water Resources and regional interests to examine the engineering alternatives and the economic, environmental, and institutional considerations that would be involved in such a major interbasin transfer of water.

The Cities of Newton, Jasper, and Kirbyville and several rural water-supply corporations in Jasper and Newton Counties have worked for many years toward the development of a central water supply and regional treated-water system to serve these areas in Zone 2 of the Sabine River

Table III-5-7. Water Resources of the Sabine River Basin, Zone 2, With Projected Water Supplies and Demands, 1990-2030[1]

Decade	Water Supply					Water Demand				Surplus or Shortage		
	In Zone	Intra-Basin	Return Flow	Import	Total	In Zone	Intra-Basin	Export	Total	M & I	Irrigation (Shortage)	Total
1990												
Ground Water	31.2	—	—	—	31.2	31.2	—	—	31.2	.0	.0	.0
Surface Water	1254.0	.0	55.1	4.2	1313.3	88.9	.0	5.6	94.5	1218.8	.0	1218.8
Total	1285.2	.0	55.1	4.2	1344.5	120.1	.0	5.6	125.7	1218.8	.0	1218.8
2000												
Ground Water	33.1	—	—	—	33.1	33.1	—	—	33.1	.0	.0	.0
Surface Water	1254.0	.0	70.0	4.9	1328.9	120.6	.0	6.5	127.1	1201.8	.0	1201.8
Total	1287.1	.0	70.0	4.9	1362.0	153.7	.0	6.5	160.2	1201.8	.0	1201.8
2010												
Ground Water	33.9	—	—	—	33.9	33.9	—	—	33.9	.0	.0	.0
Surface Water	1246.2	.0	85.9	4.9	1337.0	160.0	.0	355.6	515.6	821.4	.0	821.4
Total	1280.1	.0	85.9	4.9	1370.9	193.9	.0	355.6	549.5	821.4	.0	821.4
2020												
Ground Water	34.6	—	—	—	34.6	34.6	—	—	34.6	.0	.0	.0
Surface Water	1238.3	.0	103.8	4.9	1347.0	212.1	.0	356.9	569.0	778.0	.0	778.0
Total	1272.9	.0	103.8	4.9	1381.6	246.7	.0	356.9	603.6	778.0	.0	778.0
2030												
Ground Water	35.5	—	—	—	35.5	35.5	—	—	35.5	.0	.0	.0
Surface Water	1612.0	.0	156.2	4.9	1773.1	267.6	43.9	961.7	1273.2	499.9	.0	499.9
Total	1647.5	.0	156.2	4.9	1808.6	303.1	43.9	961.7	1308.7	499.9	.0	499.9

[1]Units in thousands of acre-feet per year. Water demands are for the "high" case. Tabulated surface water demands do not include livestock needs, some quantities of irrigation needs and other needs which will continue to be met from local, unregulated surface-face supplies.

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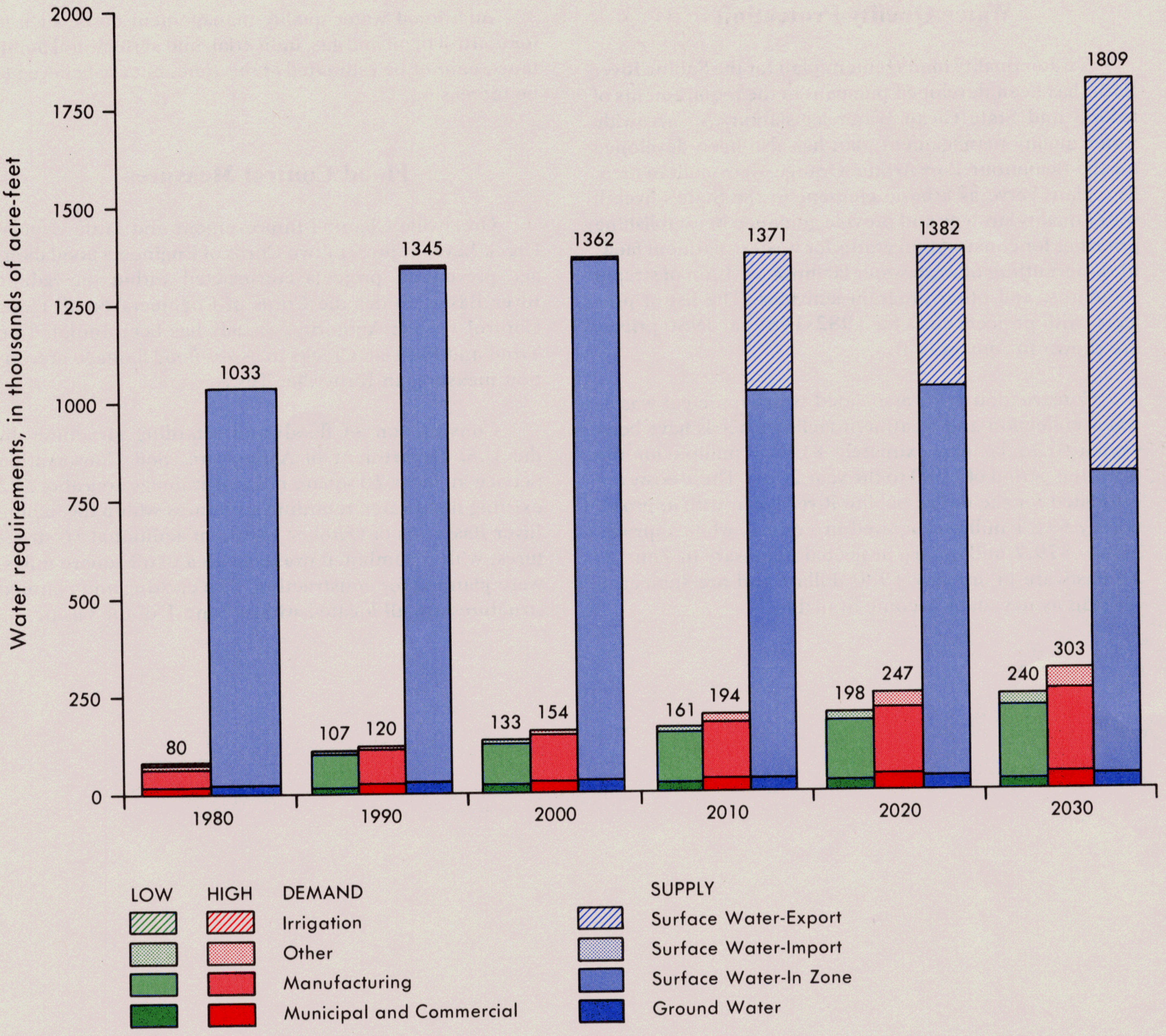

Figure III-5-4. Reported Use and Supply Source, With Projected Water Supplies and Demands, Sabine River Basin, Zone 2, 1980-2030

Basin. Although additional ground-water supplies can be developed in the Gulf Coast Aquifer in the Jasper-Newton Counties region, the ground water contains objectionable concentration of iron and is excessively corrosive due to low pH. Studies of the feasibility of a reservoir project on Big Cow Creek in Newton County have been carried on since 1955. The Sabine River Basin Comprehensive Study Report included Big Cow Creek Reservoir as a long-range project for the lower Sabine River Basin, as does the Sabine River Authority Master Plan. Independent studies completed by the Sabine River Authority indicate that a dam on Big Cow Creek approximately four miles northwest of the City of Newton, Newton County, would create a 34.2 thousand acre-foot capacity reservoir with a dependable yield of 34 thousand acre-feet annually. Construction of the Big Cow Creek project will depend upon decisions of the local interests.

Water Quality Protection

A water quality management plan for the Sabine River Basin has been developed pursuant to the requirements of federal and State Clean Water legislation. An areawide water quality management plan has also been developed for the Beaumont-Port Arthur-Orange Metropolitan area. The plans serve as a basic element in the State's overall water quality strategy and provide guidance in establishing priorities for construction grants for waste-treatment facilities, permitting of wastewater facilities, revision of stream standards, and other program activities. The list of projects, with projects costs for 1982-1989, at 1980 prices, are shown in Appendix B.

Construction costs associated with municipal wastewater collection and treatment facilities needs have been estimated to be approximately $170.8 million for the planning period of 1980 to the year 2000. These costs are estimated for the entire Sabine River Basin with approximately $91.1 million required in Zone 1, while approximately $79.7 million are projected necessary in Zone 2. All costs are in January 1980 dollars and are subject to revision as new data become available.

Additional water quality management costs, such as for control of oil and gas, industrial, and agricultural pollutants, cannot be estimated at this time, but are believed to be increasing.

Flood Control Measures

Greenville Channel Improvement and Little Cypress Creek Levee represent two Corps of Engineers flood damage prevention projects constructed within the Sabine River Basin. Under the Corps of Engineers' Small Flood Control Project Authority, a study has been initiated on Trout and Pin Oak Creeks to assess flood damage prevention measures in Kirbyville, Texas.

Construction of floodwater-retarding structures by the U.S. Department of Agriculture, Soil Conservation Service includes 70 square miles of drainage area above 22 existing floodwater-retarding structures within the Sabine River Basin. As of October 1980, an additional 16 structures, with a combined drainage area of 62 square miles, were planned for construction. The existing and planned structures are all located within Zone 1 of the basin.

6. NECHES RIVER BASIN

TABLE OF CONTENTS

TABLE OF CONTENTS—Continued

TABLES

FIGURES

TABLE OF CONTENTS—Continued

6. NECHES RIVER BASIN

BACKGROUND AND CURRENT CONDITIONS

Physical Description

The Neches River Basin is bounded on the north and east by the Sabine River Basin, on the west by the Trinity River Basin, and on the south by the Neches-Trinity Coastal Basin. The northeastern one-third of the basin area is drained by the Angelina River, while the remaining two-thirds of the 10,011 square-mile area of the basin is drained by the Neches River, Pine Island Bayou, and Village Creek. The basin empties into the Sabine Lake estuary. The Angelina River originates near Freeneytown (Rusk County) at an elevation of 290 feet and joins the Neches River at Lake B.A. Steinhagen. Headwaters of the Neches River originate near Colfax (Van Zandt County) at an elevation of about 550 feet. Downstream from the confluence with the Angelina River, the Neches River is joined by Pine Island Bayou about three miles north of Beaumont before flowing into the Sabine Lake estuary. The Neches River Basin is divided into two zones for planning purposes (Figure III-6-1).

Surface Water

The average annual runoff from 1941-70 was 522 acre-feet per square mile, and ranged from about 930 acre-feet per square mile at the mouth of the Neches River to about 376 acre-feet per square mile at the upper end of the basin. Ten of the twelve lowest annual flows from 1941 to 1970 occurred in two periods, 1951-56 and 1963-67. During 1951-56, the average annual runoff was 312 acre-feet per square mile. During 1963-67, runoff averaged 203 acre-feet per square mile annually.

The comparatively wide flood plains in the Neches River Basin have small main channels with generally flat slopes. High rainfall rates produce frequent flooding of low-lying areas, and floods of large magnitude occur on an average five-year frequency. Heavy timber and vegetation in floodways cause backwater flood problems by retarding surface runoff and flood flows. Floods in the basin are lengthy in duration, and are characterized by low flow velocities and slowly rising and falling flood peaks. Because runoff is usually slow, a broad but flat-crested flood is set in motion when substantial amounts of rain occur over periods lasting several days. The lowest portion of this basin usually remains inundated for many days, and sometimes even several weeks, during flood events.

Since virtually all of the Neches River Basin is at least 50 miles from the Gulf of Mexico, the inhabitants of the basin are not directly subject to many of the hazards associated with hurricanes. Only the extreme southern tip of the basin is concerned with destructive storm surges.

Except for localized conditions of stream degradation, inorganic water quality of the Neches River Basin is excellent with low dissolved solids and low hardness. Striker Creek Reservoir and its tributaries have experienced increased salinity due to runoff from the East Texas Oil Field. Dissolved-solids concentrations generally exceed 500 milligrams per liter (mg/l). The Angelina River near Lufkin, several miles upstream from Sam Rayburn Reservoir, contains dissolved-solids concentrations less than 150 mg/l about one-half the time, and the Neches River near Evadale in southern Jasper County also contains dissolved-solids concentrations less than 150 mg/l about 50 percent of the time.

Ground Water

Covering the upper half of the Neches River Basin is the Carrizo-Wilcox Aquifer. Thickness of this part of the aquifer ranges from about 400 feet in the outcrop to more than 2,000 feet in the downdip areas. Large-capacity wells have yields which average about 400 gallons per minute (gpm), although locally wells produce as much as 1,200 gpm. Generally, water produced from this aquifer contains less than 1,000 mg/l total dissolved solids and is suitable for most uses.

The Gulf Coast Aquifer covers the southern part of the Neches River Basin. The aquifer extends to depths of greater than 2,800 feet. Large-capacity well yields average about 1,600 gpm, but locally wells produce as much as 4,500 gpm. Total dissolved-solids concentrations of waters pumped from the aquifer are less than 500 mg/l in most areas.

The Queen City Aquifer has an extensive outcrop area which covers much of the extreme northern part of the Neches River Basin. Thickness of the aquifer ranges up to about 600 feet. Yields of wells range upward to about 400 gpm. Water in the aquifer generally contains less than 500 mg/l total dissolved solids, but quality deteriorates downdip.

The Sparta Aquifer occurs as a thin band in the central part of the Neches River Basin. Downdip, the aquifer ranges in thickness from 250 to 350 feet. No large-capacity wells are completed in the aquifer in the basin;

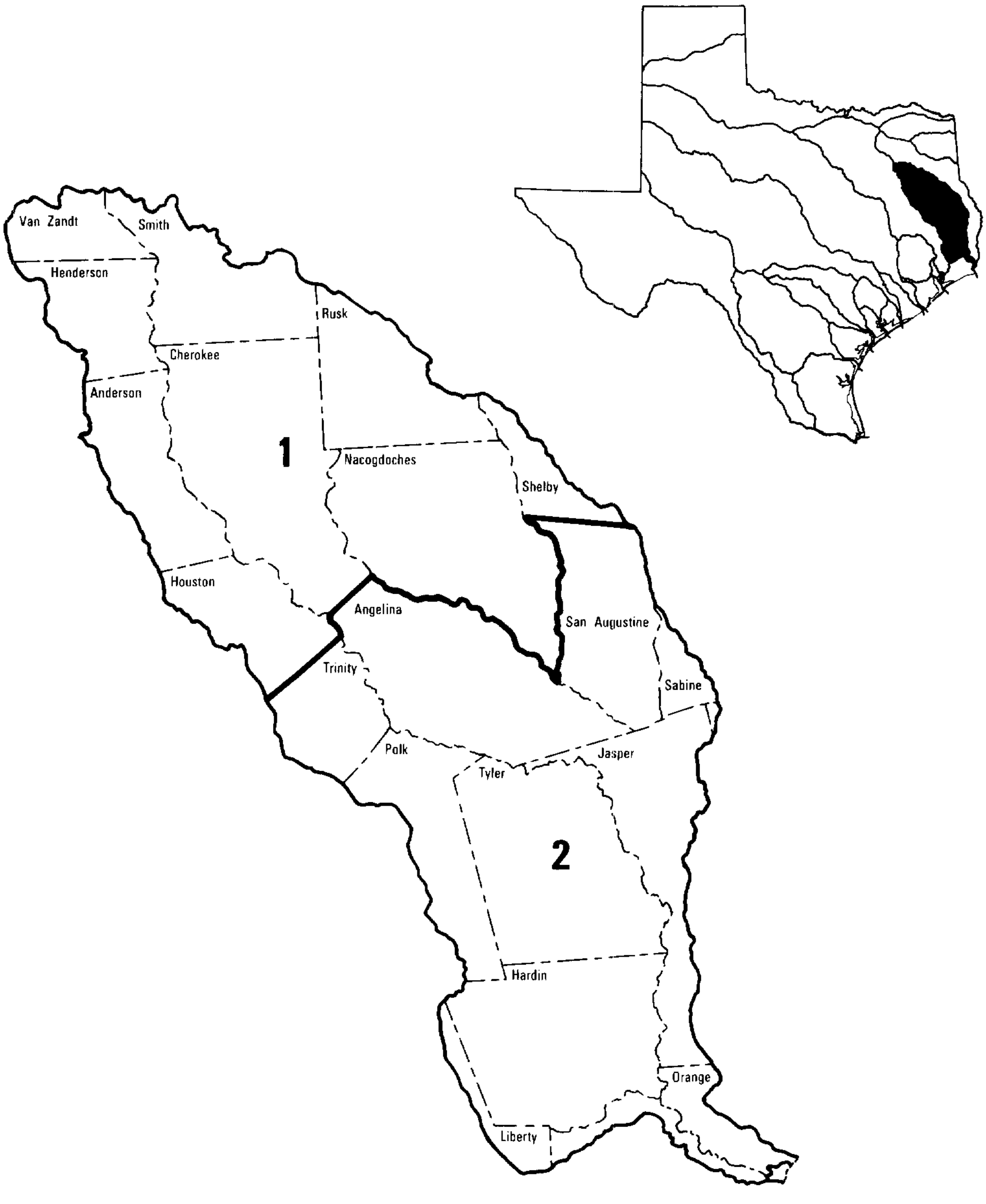

Figure III-6-1. Neches River Basin and Zones

however, based on reservoir characteristics, it is estimated that large-capacity wells would yield up to 500 gpm. Water pumped from the aquifer generally contains less than 500 mg/l total dissolved solids, but quality deteriorates rapidly downdip.

Ground waters contained in the shallow water-bearing sands of the Carrizo-Wilcox and Queen City Aquifers within the basin usually have excessive concentrations of iron and low pH (high acidity) values. Also, due to excessive pumpage, saline-water encroachment may occur from saline water-bearing sands laterally adjacent to or beneath the fresh water-bearing sands of the aquifers.

Population and Economic Development

The population of the Neches River Basin was reported at 506.3 thousand in 1980. Tyler is the largest city in the basin, having an in-basin population of 70,500 in 1980. Other basin cities having major in-basin populations are Beaumont, Lufkin, and Nacogdoches. The economy of the Neches River Basin is based on a significant timber and wood products industry, agriculture, agribusiness, manufacturing, oil, gas, and other mineral production, and recreation and tourism.

Water Use

Municipal water use in the Neches River Basin in 1980 was approximately 80.0 thousand acre-feet. Fresh water use in Zone 1 was 55 percent of basin total; Zone 2 used 45 percent of the total. Smith County, including the City of Tyler, in Zone 1 used 26 percent of the basin's total fresh water supply in 1980. In Zone 2, Angelina and Jefferson Counties consumed 28 percent of the basin total.

Industries engaged in manufacturing activities used 180.2 thousand acre-feet of fresh water in 1980. Almost 96 percent of all uses originated in Zone 2. Industries located in Zone 2 include paper and allied products, chemical, and petroleum refining industries. These are primarily located in Angelina, Jasper, and Jefferson Counties.

In 1980, there was 1,102 megawatts of steam-electric power generating capacity in the Neches River Basin. Total fresh water consumption during 1980 from surface-water sources was approximately 7.3 thousand acre-feet (this includes 2.9 thousand acre-feet of estimated net evaporation from power plant cooling resevoirs). An additional 4.9 thousand acre-feet of ground water was used.

Irrigation is not widespread in the basin, although rice production is quite important in the lower portion of Zone 2 in the coastal area. An estimate of irrigation in 1980 showed 32.4 thousand acre-feet of water was used in irrigating about 8.5 thousand acres in the basin. Surface diversions water accounted for about 24.9 thousand acre-feet. Only 0.3 thousand acre-feet was used for irrigation in Zone 1 in 1980.

In 1980, an estimated total of 4.9 thousand acre-feet of freshwater was used for mining purposes in the Neches River Basin. Of this total, mining industries in Zone 1, primarily in Anderson County, used about 2.6 thousand acre-feet, principally for petroleum and natural gas production. About 2.3 thousand acre-feet of water was used in Zone 2, principally for nonmetal mining operations.

Livestock water use in the Neches River Basin for 1980 totaled about 8.3 thousand acre-feet. About 6.7 thousand acre-feet was used in Zone 1 and 1.6 thousand acre-feet was used in Zone 2.

Navigation facilities in the Neches River Basin include portions of the Sabine-Neches Waterway—the Sabine-Neches Canal and the Neches River to Beaumont. These marine navigation facilities have no regulated freshwater requirements.

Hydroelectric power generating facilities are located in Sam Rayburn Dam, which has a hydroelectric generating capacity of 52 megawatts. Maximum design work release rating of the turbines is 0.205 feet per second per kilowatt.

Return Flows

Of the 164.7 thousand acre-feet of municipal and manufacturing return flows in the Neches River Basin in 1980, industrial fresh water return flows totaled 128.9 thousand acre-feet.

Practically all of the irrigation return flows in the Neches River Basin were from rice-producing acreage in the lower basin. Return flows represented about 40 percent of the water applied for irrigation, or about 7.4 thousand acre-feet in 1980. Most return flows from rice irrigation are discharged near the Coast and therefore are unavailable for reuse.

Current Ground-Water Development

In 1980, approximately 147.6 thousand acre-feet of ground water was used in the Neches River Basin. Of this amount, 35.3 thousand acre-feet was used in Zone 1, and 112.3 thousand acre-feet in Zone 2. In Zone 1 in 1980, about 83 percent of the ground water used was from the Carrizo-Wilcox Aquifer, and about 13 percent was from the Queen City Aquifer. In Zone 2, about 70 percent of the ground water used was from the Gulf Coast Aquifer, and about 25 percent was from the Carrizo-Wilcox Aquifer.

Of the 147.6 thousand acre-feet of ground water used in the basin approximately 129.1 thousand acre-feet or 87 percent was used for municipal and manufacturing purposes.

In 1980, overdrafts of ground water did not occur in Zone 1 of the basin. However, significant overdrafts of ground water occurred in Zone 2, and were evident in Angelina County from the Carrizo-Wilcox Aquifer for manufacturing purposes, and in Jasper and Orange Counties from the Gulf Coast Aquifer for manufacturing and steam-electric power generation purposes.

Current Surface-Water Development

There are ten existing major reservoirs located in the Neches River Basin, seven in Zone 1 and three in Zone 2. Major reservoirs located in Zone 1 are Athens, Palestine, Jacksonville, Tyler, Striker Creek, Nacogdoches, and Pinkston. Lake Athens, owned by the Athens Municipal Water Authority, is located on Flat Creek in Henderson County and provides municipal water to the City of Athens in the Trinity River Basin. Lake Palestine, located on the Neches River in Anderson and Cherokee Counties, is owned and operated by the Upper Neches River Municipal Water Authority for municipal and industrial purposes. Conservation storage in the reservoir is allocated by agreement to the Upper Neches River Municipal Water Authority (46.27 percent) and to the City of Dallas (53.73 percent) in the Trinity River Basin. Lake Jacksonville, located on Gum Creek in Cherokee County, is owned by the City of Jacksonville for municipal and recreational uses. Lake Tyler is located upstream from the confluence of Mud and Prairie Creeks in Smith County. Separate dams impound two individual reservoirs joined by a connecting canal which collectively form Lake Tyler. The reservoir is owned and operated by the City of Tyler for municipal water supplies. Striker Creek Reservoir, owned by the Angelina and Nacogdoches Counties Water Control and Improvement District No. 1, is located on Striker Creek in Rusk and Cherokee Counties. The reservoir provides water for industrial purposes and steam- electric power plant cooling. Lake Nacogdoches is located on Bayou Loco in Nacogdoches County. The reservoir is owned and operated by the City of Nacogdoches for municipal water supply purposes. Pinkston Reservoir, located on Sandy Creek southwest of Shelby in Shelby County, is owned and operated by the City of Center in the Sabine River Basin, and supplies the city's municipal water needs.

Zone 2 reservoirs include Kurth, Sam Rayburn, and B.A. Steinhagen. Lake Kurth is located in Angelina County and is operated as an off-channel storage project for industrial water diversions from the Angelina River by Southland Paper Mills, Inc. Sam Rayburn Reservoir and B.A. Steinhagen Lake were constructed and are operated by the Corps of Engineers. Sam Rayburn, located on the Angelina River in Jasper County, provides storage for municipal, industrial, and irrigation supplies; hydroelectric power generation; and flood control. B.A. Steinhagen Lake is located on the Neches River below the confluence of the Neches and Angelina Rivers in Tyler and Jasper Counties. Permit provisions authorize the Lower Neches Valley Authority to appropriate water for municipal, industrial, and irrigation uses from Sam Rayburn Reservoir, such waters to be impounded and re-regulated in B.A. Steinhagen Lake.

Water Rights

A total of 1,787,721 acre-feet of surface water was authorized or claimed in the Neches River Basin as of December 31, 1983 (Table III-6-1). Municipal use

Table III-6-1. Authorized or Claimed Amount of Water, by Type of Right, Neches River Basin[1]

Type of Authorization	Number of Rights	Acre-Feet Authorized and Claimed
Permits	130	1,325,907
Claims	331	369,424
Certified Filings	4	92,390
Certificates of Adjudication	0	0
Total Authorizations and Claims	465	1,787,721

[1]The Texas Water Rights Adjudication Act of 1967 authorizes the Texas Department of Water Resources to investigate and determine, with the Court's approval, the nature and measure of water rights for all authorized diversions from surface-water streams or portions thereof except domestic and livestock uses and to monitor and administer each adjudicated water right. These totals incorporate the results of water-rights adjudication in the basin as of December 31, 1983. These totals do not include 7 authorized diversions of saline water amounting to 1,019,653 acre-feet/year. Certified Filings are declarations of appropriation which were filed with the State Board of Water Engineers under the provisions of Section 14, Chapter 171, General Laws, Acts of the 33rd Legislature, 1913, as amended. Permits are statutory appropriative rights which have been issued by the Texas Water Commission or its predecessor agencies. Claims are sworn statements of historical uses to be adjudicated in accordance with the Texas Water Rights Adjudication Act. A certificate of adjudication is the final result after recognition of a valid right in the adjudication process and is based on a permit, certified filing or claim or any combination of the three.

accounted for 26.7 percent of the total amount of water authorized and/or claimed in the basin (Table III-6-2). Over 78 percent of the total quantity of water authorized or claimed in the basin for all uses is in Zone 2.

Water Quality

Lowlands along the Neches River consist of fresh- and salt-water marsh areas. Stagnant water is flushed into the Neches River during high runoff conditions. Problems of low dissolved-oxygen concentrations occur locally during low-flow conditions and during the warm weather seasons. Areas adjacent to the tidally-influenced reach of the Neches River are heavily industrialized. Upstream diversions, particularly during the rice growing season, result in the lower reach of the river being frequently composed entirely of treated municipal and industrial effluent. Cedar Creek below Lufkin frequently contains low dissolved-oxygen concentrations due to discharges of treated municipal and industrial effluents. Since more than 75 percent of the drainage area of the upper Neches River is forested, decaying vegetation creates natural non-point pollution sources, with the decaying matter in the river and its tributaries exerting seasonally variable oxygen demands on the stream. Relatively high fluoride concentrations occur locally in the Sparta and Carrizo-Wilcox Aquifers, and high iron concentrations occur in all of the aquifers in the basin. In many areas, water in the Queen City Aquifer is corrosive and therefore objectionable without pretreatment.

Flooding, Drainage, and Subsidence

Flood damages in the upper part of the basin are primarily restricted to agricultural property, timberlands, and logging facilities. Urban damages occur along Ayish Bayou at San Augustine, Bayou LaNana at Nacogdoches, and several small communities located on principal tributaries. Significant urban flood damages also occur in the general vicinity of Beaumont. Floods in 1957, 1969, 1973, 1974, 1975, and 1976 caused an estimated $2.8 million in damages to property within the basin. Damages were severe enough in Jefferson and Orange Counties during the June 1973 flood to warrant a Presidential disaster declaration. Hardin, Jasper, and Tyler Counties were included in the 12-county disaster areas due to severe flooding in July 1973.

As a result of the February 1975 flood in Nacogdoches County, five political entities received over $300 thousand in federal disaster relief funds. Heavy flooding hit the lower basin again in 1979 and 1980. Hardin, Orange, and Tyler Counties were included in a Presidential flood disaster declaration in April 1979 with over $1.3 million spent in the federal relief effort. A major flood in Nacogdoches again resulted in another disaster declaration with over $72 thousand in federal money spent for flood relief. During the period 1978-1981, 373 flood insurance claims were made for over $2.7 million in flood damages.

Use of the National Flood Insurance Program to provide a means of protection against financial losses due to flooding has not been widespread in the Neches River Basin. Of the 50 cities within the basin designated as flood prone by the Federal Emergency Management Agency, only 28 cities have adopted the flood-plain management criteria necessary for participation in the Program. Officials of Hardin, San Augustine, Smith, Liberty, Jefferson, and Orange Counties have adopted FEMA's flood-plain management standards to make flood insurance available to residents of the unincorporated areas. The City of Port Neches is currently a participant in the Regular Phase of the Program. Detailed flood insurance rate studies used to convert communities to Regular Program status are currently underway for the Cities of Nacogdoches, Vidor, and in all unincorporated areas and incorporated cities in Hardin County.

Inadequate natural drainage compounds drainage problems in the Neches River Basin system. Narrow channels and depressions which drain the basin have very low gradients. Surface runoff from heavy rainfall moves slowly through vegetation-choked channels, resulting in frequent inundation of wide areas for long periods of time. In many areas, soil conditions inhibit adsorption of surface water, thus compounding the drainage problem.

Land subsidence due to compaction of clays caused by ground-water withdrawals from the Gulf Coast Aquifer is a

Table III-6-2. Authorized or Claimed Amount of Water, by Type of Use and Zone, in Acre-Feet, Neches River Basin

Type of Use	Number of Rights	Zone 1	Zone 2	Total
Municipal	23	315,141	162,483	477,624
Industrial[2]	28	31,371	1,027,628	1,058,999
Irrigation	333	14,958	203,702	218,660
Mining	2	60	0	60
Recreation	90	23,461	8,877	32,338
Other	1	40	0	40
Total	465[1]	385,031	1,402,690	1,787,721

[1]Does not sum due to multipurpose "rights", which may be applied to more than one type of use.

[2]Does not include 8 authorized diversions of saline water in Zone 2 amounting to 1,019,653 acre-feet year.

potential problem in southern Hardin, southern Jasper, northern Jefferson, and western Orange Counties within the Neches River Basin. Also, fault activation and movement which can cause considerable damage to property are associated with subsidence. Damages caused by fault movement are very evident in urban areas of the Gulf Coastal Plain. Subsidence and fault movement also are caused locally by withdrawals of petroleum and associated saline waters and by extractions of sulfur and other minerals in the Gulf Coastal Plain.

Recreation Resources

Reservoirs within the Neches River Basin provide over 168.0 thousand surface acres available for water-oriented recreation activities. Three of these reservoirs located in Zone 2 account for approximately 77 percent of the total basin surface-water area. Sam Rayburn Reservoir, located in Zone 2, is the second largest lake in the State with 114.5 thousand surface acres. Over 2.6 million visitors were reported by the U.S. Army Corps of Engineers at Sam Rayburn Reservoir during 1980. Lake Palestine (25.6 thousand surface acres) is the largest reservoir in Zone 1 of the basin.

PROJECTED WATER REQUIREMENTS

Population Growth

The Neches River Basin population should increase by 111 percent by the year 2030, approaching 1.1 million residents (Table III-6-3). A 39 percent increase is anticipated by 2000, and a 52 percent increase from 2000 to 2030. These growth rates are slightly below those of the entire State, which are 49 percent and 62 percent, respectively, for the 1980-2000 and 2000-2030 time periods.

Smith County, including Tyler, had the largest share of the basin population in 1980, 22.1 percent. Tyler's population should increase to nearly 25 percent of the basin total by 2030. Angelina County is the next most populous county, containing 13 percent of the basin total.

Water Requirements

Municipal

Municipal water requirements are projected for two cases of future growth based on population changes and per capita water use. Water requirements in the Neches River Basin are projected to increase by 22 to 86 percent by 2000; low and high case, respectively. By 2030, water requirements are projected to range from 135.9 thousand acre-feet (low case) to 224.7 thousand acre-feet (high case). Municipal water requirements are almost equally divided between zones.

Industrial

Projections of future water requirements for manufacturing purposes were made by decade and for a low and high case for each industrial group. In 1980, over 90 percent of total manufacturing water use was concentrated in five industrial groups: chemicals, petroleum refining, primary metals, paper products, and food products. Because of this concentration, careful attention was given to the future growth outlook for these industries in making the projections.

Manufacturing freshwater requirements in the Neches River Basin are projected to more than double by the year 2030, from a 1980 requirement of 180.2 thousand acre-feet to a 2030 requirement of 371.1 to 417.0 thousand acre-feet annually (Table III-6-3). In comparison, State manufacturing freshwater requirements will more than double over the planning period (230 percent relative to 130 percent for the Neches River Basin). Consequently, while 11.9 percent of 1980 State manufacturing freshwater requirement originated in the Neches, this basin is projected to provide only 8.3 percent of the 2030 total.

Zone 2 (Jefferson, Jasper, and Angelina Counties) of the Neches River Basin is expected to require over 92 percent of the 2030 basin demands. Petroleum refining and chemical production are projected as the heaviest industrial freshwater users in Jefferson County. Paperboard mills in Jasper County and Angelina County will constitute the major sources of increased water requirements.

Steam-Electric Power Generation

Although near-surface lignite deposits are substantially lower in the Neches River Basin than in the Sabine and Trinity Basins, these deposits will still be a factor in the future growth of steam-electric power generating capacity in the basin.

Future growth was projected for two electricity demand cases. Water requirements are projected to increase from 12.2 thousand acre-feet for 1980 by 275 to 518 percent by 2030; low and high case, respectively. The increased demand for electricity is divided approximately equally between zones.

Table III-6-3. Population, Current Water Use, With Projected Population and Water Requirements, 1990-2030[a]
Neches River Basin

River Basin Zone & Category of Use	1980 Ground Water	1980 Surface Water	1980 Total	1990 Ground Water	1990 Surface Water	1990 Total	2000 Ground Water	2000 Surface Water	2000 Total	2010 Ground Water	2010 Surface Water	2010 Total	2020 Ground Water	2020 Surface Water	2020 Total	2030 Ground Water	2030 Surface Water	2030 Total
Zone 1																		
Population			259.9			323.7			366.6			410.5			465.5			526.4
Municipal	26.2	17.6	43.8	24.4	43.8	68.2	26.4	52.8	79.2	28.0	60.6	88.6	30.3	70.1	100.4	33.1	80.3	113.4
Manufacturing	3.5	4.4	7.9	5.5	7.8	13.3	5.9	10.9	16.8	6.3	14.2	20.5	6.8	18.2	25.0	7.4	23.1	30.5
Steam Electric	0.3	5.3	5.6	0.0	5.6	5.6	0.0	12.4	12.4	0.0	21.7	21.7	0.0	31.1	31.1	0.0	40.4	40.4
Mining	2.1	0.5	2.6	1.3	0.7	2.0	0.5	16.9	17.4	10.7	7.7	18.4	11.5	7.9	19.4	3.2	1.3	4.5
Irrigation	0.1	0.2	0.3	0.0	0.3	0.3	0.0	0.3	0.3	0.0	0.3	0.3	0.0	0.3	0.3	0.0	0.3	0.3
Livestock	3.1	3.6	6.7	2.2	5.7	7.9	2.2	7.0	9.2	2.1	7.1	9.2	2.1	7.1	9.2	2.2	7.0	9.2
Zone Total Water	35.3	31.6	66.9	33.4	63.9	97.3	35.0	100.3	135.3	47.1	111.6	158.7	50.7	134.7	185.4	45.9	152.4	198.3
Zone 2																		
Population			246.4			296.8			338.7			391.5			457.2			544.2
Municipal	29.1	7.1	36.2	30.2	29.4	59.6	36.1	33.5	69.6	45.2	37.8	80.3	49.0	44.6	93.6	57.1	54.2	111.3
Manufacturing	70.3	102.0	172.3	14.8	196.8	211.6	15.1	234.9	250.0	17.3	270.3	287.6	15.5	317.3	332.8	14.9	371.6	386.5
Steam Electric	4.6	2.0	6.6	2.0	4.6	6.6	2.0	11.4	13.4	2.0	18.6	20.6	2.0	25.8	27.8	2.0	33.0	35.0
Mining	0.1	2.2	2.3	0.1	2.8	2.9	0.1	3.4	3.5	0.1	4.0	4.1	0.1	4.5	4.6	0.0	5.1	5.1
Irrigation	7.4	24.7	32.1	5.4	14.1	19.5	5.4	14.1	19.5	5.4	14.1	19.5	5.4	14.1	19.5	2.8	16.7	19.5
Livestock	0.8	0.8	1.6	0.7	1.2	1.9	0.7	1.5	2.2	0.8	1.4	2.2	0.7	1.5	2.2	0.8	1.4	2.2
Zone Total Water	112.3	138.8	251.1	53.2	248.9	302.1	59.4	298.8	358.2	68.1	346.2	414.3	72.7	407.8	480.5	77.6	482.0	559.6
BASIN TOTALS																		
Population			506.3			620.5			705.3			802.0			922.7			1,070.6
Municipal	55.3	24.7	80.0	54.6	73.2	127.8	62.5	86.3	148.8	70.5	98.4	168.9	79.3	114.7	194.0	90.2	134.5	224.7
Manufacturing	73.8	106.4	180.2	20.3	204.6	224.9	21.0	245.8	266.8	23.6	284.5	308.1	22.3	335.5	357.8	22.3	394.7	417.0
Steam Electric	4.9	7.3	12.2	2.0	10.2	12.2	2.0	23.8	25.8	2.0	40.3	42.3	2.0	56.9	58.9	2.0	73.4	75.4
Mining	2.2	2.7	4.9	1.4	3.5	4.9	0.6	20.3	20.9	10.8	11.7	22.5	11.6	12.4	24.0	3.2	6.4	9.6
Irrigation	7.5	24.9	32.4	5.4	14.4	19.8	5.4	14.4	19.8	5.4	14.4	19.8	5.4	14.4	19.8	2.8	17.0	19.8
Livestock	3.9	4.4	8.3	2.9	6.9	9.8	2.9	8.5	11.4	2.9	8.5	11.4	2.8	8.6	11.4	3.0	8.4	11.4
Basin Total Water	147.6	170.4	318.0	86.6	312.8	399.4	94.4	399.1	493.5	115.2	457.8	573.0	123.4	542.5	665.9	123.5	634.4	757.9

a/ Population in thousands of persons, water requirements in thousands of acre-feet per year.

Agriculture

Irrigation

Irrigation water requirements were projected for two cases of change based on improvements in on-farm application efficiencies, reduction in ditch losses, changes in future resource costs and crop prices, and corresponding changes in cropping patterns to reflect more profitable crops. A low case projects demand for water based on the effects of changes in the above variables but with irrigated acreage held constant at 1980 levels in each zone for each future time period; a high case projects demand for water for irrigation constrained only by the requirement that irrigated farming produce a net positive return in excess of that possible from dryland farming and the requirement not to exceed the amount of irrigable soil in each zone. Thus, the projections of demand, low and high cases, based on the irrigation efficiency and market conditions mentioned above, give an estimate of the quantity of water needed for irrigation in each zone, at each decadal point for which projections were made. These projections of demand are compared to the projected supply of water locally available. When projected demand exceeds projected supply, the difference is a measure of shortage at that point in time.

Irrigation water requirements in the Neches River Basin are projected to decrease from the 1980 level of 32.4 thousand acre-feet by a projected maximum 39 percent by the year 2000 in the high and low case. In the year 2030, water requirements in the Basin are projected to remain at 19.8 thousand acre-feet annually in both the low and high case, respectively, to irrigate about 8.5 thousand acres.

Zone 2 is projected to account for about 98 percent of total basin irrigation requirements in 2000 and 2030. Zone 1 is projected to account only for about two percent of the total.

Livestock

In 1980, livestock water requirements within the basin were 8.3 thousand acre-feet annually (Table III-6-3). Approximately 81 percent of the total was used in Zone 1. By 2030, 11.4 thousand acre-feet of water will be required for livestock needs.

Mining

Mining freshwater use in the Neches River Basin is projected to increase from 4.9 thousand acre-feet in 1980 to 9.6 thousand acre-feet in 2030 (Table III-6-3). Fuel extraction water requirements (crude petroleum and natural gas) will decline from 2,170 acre-feet to 215 acre-feet annually in 2030, while the basin nonmetal mining freshwater requirements are expected to double over the 50-year period.

Navigation

As part of an authorized comprehensive study of the Neches River and its tributaries, the Corps of Engineers has completed and released a report relating to construction of a permanent salt water barrier on the Neches River. The freshwater requirements associated with the navigation aspects of the project would be approximately 10,000 acre-feet annually.

Hydroelectric Power

Hydroelectric power generation capacity in the Neches River Basin is limited to 52 megawatts at Sam Rayburn Dam. There are no current plans to expand generating capacity.

Estuarine Freshwater Inflows

The Neches River, along with the Sabine River, discharges into the Sabine-Neches estuary. Estimates of freshwater inflow needs for the Sabine-Neches estuary are based on the total flow from both river basins. These estimates are presented in Table III-5-4, of the Sabine Basin discussion.

WATER SUPPLY PROJECTS AND MEASURES TO MEET FUTURE BASIN NEEDS

Ground-Water Availability and Proposed Development

The approximate annual ground-water yield within the Neches River Basin to the year 2030 is 570.8 thousand acre-feet with the following amounts annually available by aquifer: 154.1 thousand acre-feet from the Carrizo-Wilcox Aquifer, 101.0 thousand acre-feet from the Gulf Coast Aquifer, 54.4 thousand acre-feet from the Sparta Aquifer, and 261.3 thousand acre-feet from the Queen City Aquifer. Since the ground water available from the Queen City Aquifer within the basin has high concentrations of iron and high acidity (low pH), it should not be considered a suitable source of water for municipal and most manufacturing purposes. However, Queen City ground water is suitable for irrigation, steam-electric power generation (cooling), mining, and stock watering purposes. In the year 2030, the yield of the Carrizo-Wilcox Aquifer within the basin would be reduced to the aquifer's average annual recharge of 150.0 thousand acre-feet per year. This reduction decreases the total ground-water availability within the basin in 2030 to 566.7 thousand acre-feet. Consequently, since less ground water will be available in 2030, the total ground-water use projected for the basin in 2030 also may be reduced.

The projected annual ground-water use within the Neches River Basin by decade from 1990 through 2030 is expected to be from 86.6 to 123.5 thousand acre-feet per year (Table III-6-3). The approximate average annual projected ground-water use within the basin is expected to be about 108.7 thousand acre-feet per year. Of the 108.7 thousand acre-feet of average annual projected use, about 49 percent is expected to be from the Gulf Coast Aquifer, about 47 percent from the Carrizo-Wilcox Aquifer, and about 1 percent from the Queen City Aquifer.

Surface-Water Availability and Proposed Development

Surface-water requirements projected for the Neches River Basin and for adjacent areas supplied by exports from this basin are estimated to be fully satisfied through the year 2030, except for minor irrigation shortages, based upon supplies from existing and proposed reservoir development (Table III-6-4, Figure III-6-2).

Zone 1

Zone 1 of the Neches River is projected to have a surface-water surplus for existing reservoirs of 67.9 thousand acre-feet in the year 2030 (Table III-6-5, Figure III-6-3). Total surface-water supply available is projected to be some 364.4 thousand acre-feet in year 2030, with surface-water requirements totaling an estimated 296.5 thousand acre-feet. Approximately 142.5 thousand acre-feet of the water demand on Zone 1 in 2030 is assigned for export to the upper Trinity River Basin.

There are three potential reservoir projects in Zone 1 of the Neches River Basin, Weches, Ponta, and Eastex Reservoirs. The proposed site of Weches Reservoir is located on the Neches River in Houston and Cherokee Counties. As presently designed, it would provide for flood control, water conservation and supply, recreation, and potentially could be used for hydroelectric power production. Although presently inactive, studies have been performed by the Corps of Engineers to examine the possibility of enlarging the authorized design capacity of the authorized Rockland Reservoir Project in Zone 2, downstream of Weches, and eliminating this potential project.

The proposed site of Ponta Reservoir is located on the Angelina River in Cherokee and Nacogdoches Counties upstream from Sam Rayburn Reservoir. Ponta Reservoir has been studied extensively by the Corps of Engineers. The project would provide 649.2 thousand acre-feet of flood-control storage and 804.8 thousand acre-feet of conservation storage, as well as recreation and the potential for hydroelectric power generation.

The proposed Lake Eastex is located in Cherokee County, upstream of the proposed Ponta Reservoir. The project has been studied by local interests as a water supply reservoir for municipal and industrial purposes. Construction of the project will depend upon local initiative.

Zone 2

A projected surface-water surplus of 18.6 thousand acre-feet based upon existing and proposed reservoirs is estimated to occur in year 2030 in Zone 2 of the basin (Table III-6-6, Figure III-6-4). Approximately 1.23 million acre-feet of the total estimated 1.71 million acre-feet of surface-water requirement on the zone in 2030 is projected to occur outside of the basin. The majority of this export demand in the year 2030 would be in the San Jacinto, San Jacinto-Brazos, and lower Brazos River Basins. Slight shortages in projected future irrigation are forecast to occur in this zone due to limiting supplies of ground water.

Although additional reservoir projects are not needed in Zone 2 to meet water supply needs of the basin through 2030, a major water storage facility is needed now to solve a long-standing water supply problem. During periods of low flow and high water withdrawals, salt water from the Gulf of Mexico intrudes up the Neches River in sufficient quantity to contaminate the freshwater supplies diverted from the river by the City of Beaumont and the Lower Neches Valley Authority. To prevent contamination of its water supply, the Lower Neches Valley Authority, through the years, has adopted the practice of installing temporary salt-water barriers downstream from their diversion points for 4 to 6 months every year. Although these temporary barriers are effective and economical, they completely block navigation by recreational and commercial vessels.

Construction of the Corps of Engineers authorized Salt Water Barrier project at Beaumont would permanently eliminate this problem. The project would provide a

Table III-6-4. Water Resources of the Neches River Basin, With Projected Water Supplies and Demands, 1990-2030[1]

	Water Supply					Water Demand				Surplus or Shortage		
Decade	In Basin	Intra-Basin	Return Flow	Import	Total	In Basin	Intra-Basin	Export	Total	M & I	Irrigation (Shortage)	Total
1990												
Ground Water	86.6	—	—	—	86.6	86.6	—	—	86.6	.0	.0	.0
Surface Water	1255.1	—	90.0	6.1	1351.2	289.2	—	474.8	764.0	589.4	(2.2)	587.2
Total	1341.7	—	90.0	6.1	1437.8	375.8	—	474.8	850.6	589.4	(2.2)	587.2
2000												
Ground Water	94.4	—	—	—	94.4	94.4	—	—	94.4	.0	.0	.0
Surface Water	1253.5	—	104.2	7.1	1364.8	373.2	—	456.9	830.1	536.9	(2.2)	534.7
Total	1347.9	—	104.2	7.1	1459.2	467.6	—	456.9	924.5	536.9	(2.2)	534.7
2010												
Ground Water	115.2	—	—	—	115.2	115.2	—	—	115.2	.0	.0	.0
Surface Water	1240.7	—	118.0	8.1	1366.8	431.2	—	660.5	1091.7	277.3	(2.2)	275.1
Total	1355.9	—	118.0	8.1	1482.0	546.4	—	660.5	1206.9	277.3	(2.2)	275.1
2020												
Ground Water	123.4	—	—	—	123.4	123.4	—	—	123.4	.0	.0	.0
Surface Water	1910.4	—	134.1	9.4	2053.9	515.0	—	1153.5	1668.5	387.6	(2.2)	385.4
Total	2033.8	—	134.1	9.4	2177.3	638.4	—	1153.5	1791.9	387.6	(2.2)	385.4
2030												
Ground Water	123.5	—	—	—	123.5	123.5	—	—	123.5	.0	.0	.0
Surface Water	1897.6	—	153.6	11.1	2062.3	606.5	—	1369.3	1975.8	91.2	(4.7)	86.5
Total	2021.1	—	153.6	11.1	2185.8	730.0	—	1369.3	2099.3	91.2	(4.7)	86.5

[1]Units in thousands of acre-feet per year. Water demands are for the "high" case. Tabulated surface water demands do not include livestock needs, some quantities of irrigation needs and other needs which will continue to be met from local, unregulated surface-water supplies.

Definitions
- Intra-Basin: A transfer of water among zones within a river basin.
- Import: A transfer of water from another river basin.
- Return Flows: Wastewater returned to a natural stream channel that can be recaptured at a downstream point.
- Export: A transfer of water to another river basin.

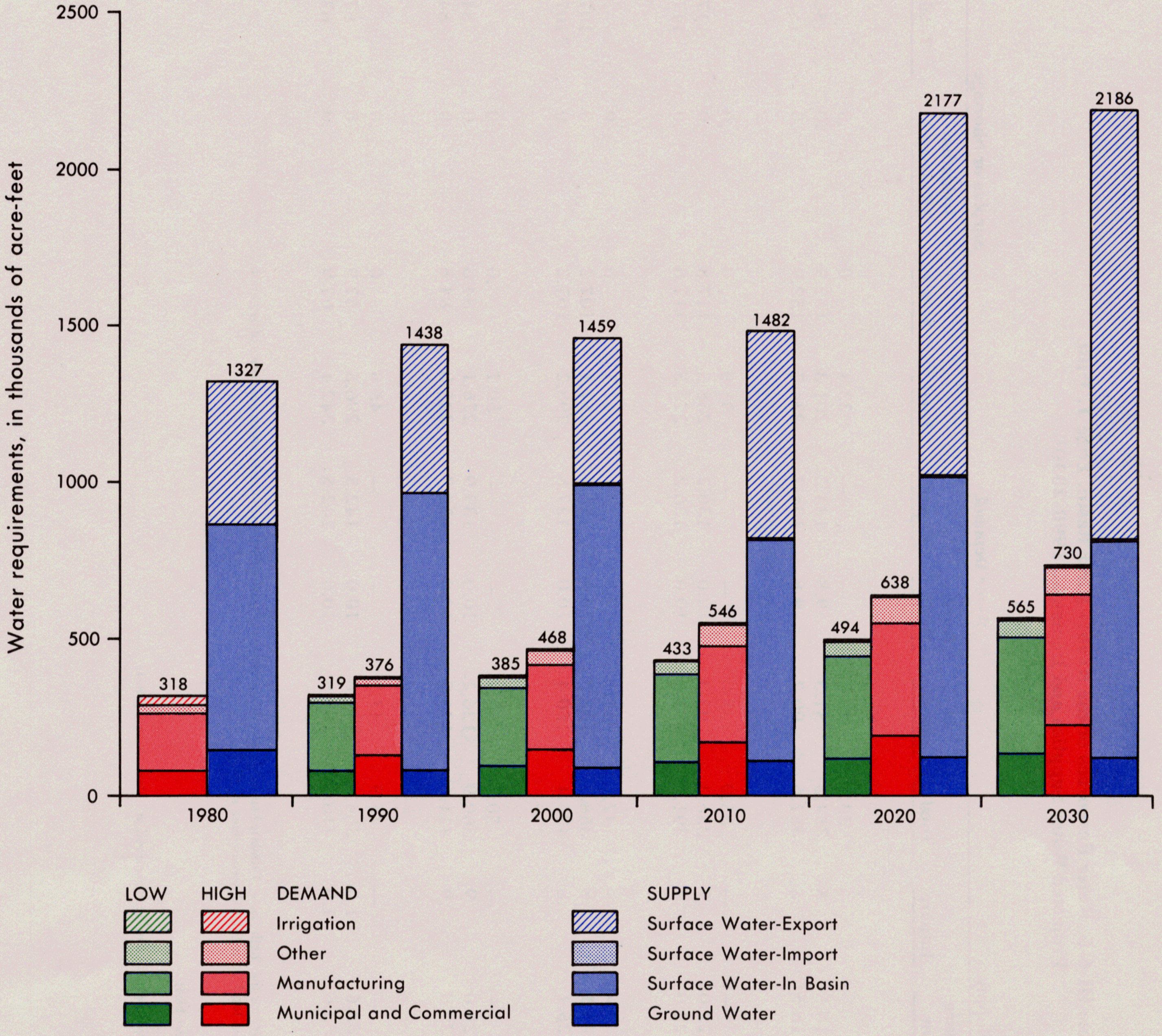

Figure III-6-2. Reported Use and Supply Source, With Projected Water Supplies and Demands, Neches River Basin, 1980-2030

navigation gate by-pass channel, auxiliary dam, and appurtenances to permanently control salt-water intrusion in the Neches River and tributaries. The freshwater requirements associated with the navigational aspects of the project would be approximately 10,000 acre-feet annually. These requirements can be met from projected surplus supplies in Zone 2 of the Neches River Basin.

Existing surface-water resources in the Neches River Basin exceed projected surface-water needs in the Neches River Basin and Zone 1 of the Neches-Trinity Coastal Basin through the year 2030. However, projected needs in the Houston-Galveston metropolitan area and in Zone 6 of the Brazos River Basin could necessitate providing additional water supplies for that area. Studies performed by

Table III-6-5. Water Resources of the Neches River Basin, Zone 1, With Projected Water Supplies and Demands, 1990-2030[1]

	Water Supply					Water Demand				Surplus or Shortage		
Decade	In Zone	Intra-Basin	Return Flow	Import	Total	In Zone	Intra-Basin	Export	Total	M & I	Irrigation (Shortage)	Total
1990												
Ground Water	33.4	—	—	—	33.4	33.4	—	—	33.4	.0	.0	.0
Surface Water	335.2	.0	18.5	.5	354.2	57.3	9.8	134.2	201.3	152.9	.0	152.9
Total	368.6	.0	18.5	.5	387.6	90.7	9.8	134.2	234.7	152.9	.0	152.9
2000												
Ground Water	35.0	—	—	—	35.0	35.0	—	—	35.0	.0	.0	.0
Surface Water	333.6	.0	22.0	.7	356.3	92.3	10.0	136.2	238.5	117.8	.0	117.8
Total	368.6	.0	22.0	.7	391.3	127.3	10.0	136.2	273.5	117.8	.0	117.8
2010												
Ground Water	47.1	—	—	—	47.1	47.1	—	—	47.1	.0	.0	.0
Surface Water	332.4	.0	25.1	.8	358.3	103.3	10.0	137.8	251.1	107.2	.0	107.2
Total	379.5	.0	25.1	.8	405.4	150.4	10.0	137.8	298.2	107.2	.0	107.2
2020												
Ground Water	50.7	—	—	—	50.7	50.7	—	—	50.7	.0	.0	.0
Surface Water	331.0	.0	29.0	.9	360.9	126.2	10.0	139.9	276.1	84.8	.0	84.8
Total	381.7	.0	29.0	.9	411.6	176.9	10.0	139.9	326.8	84.8	.0	84.8
2030												
Ground Water	45.9	—	—	—	45.9	45.9	—	—	45.9	.0	.0	.0
Surface Water	329.8	.0	33.6	1.0	364.4	144.0	10.0	142.5	296.5	67.9	.0	67.9
Total	375.7	.0	33.6	1.0	410.3	189.9	10.0	142.5	342.4	67.9	.0	67.9

[1]Units in thousands of acre-feet per year. Water demands are for the "high" case. Tabulated surface water demands do not include livestock needs, some quantities of irrigation needs and other needs which will continue to be met from local, unregulated surface-face supplies.

Definitions

Intra-Basin: A transfer of water among zones within a river basin.

Import: A transfer of water from another river basin.

Return Flows: Wastewater returned to a natural stream channel that can be recaptured at a downstream point.

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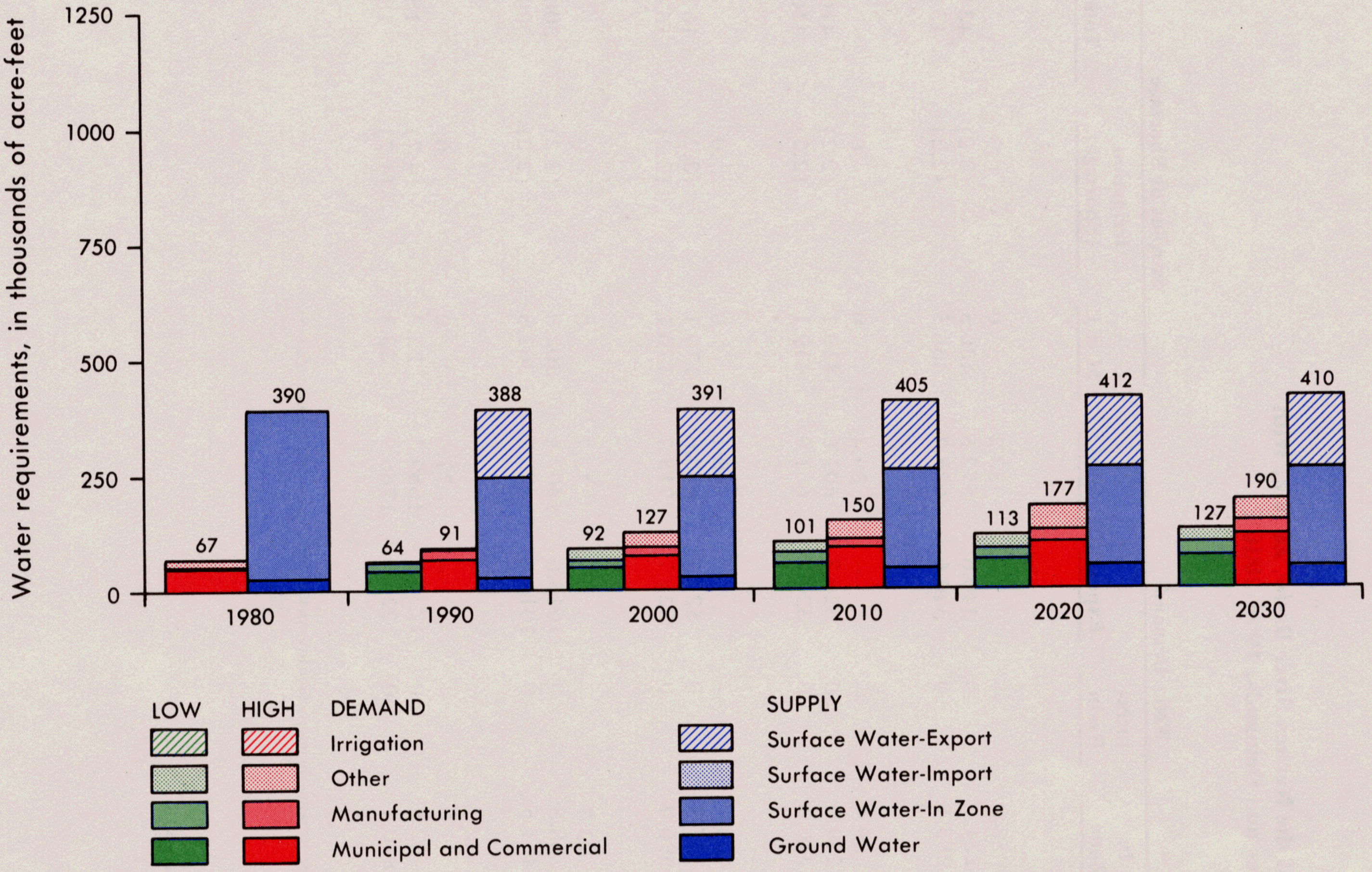

Figure III-6-3. Reported Use and Supply Source, With Projected Water Supplies and Demands, Neches River Basin, Zone 1, 1980-2030

and for the Texas Department of Water Resources indicate that it is physically feasible to convey relatively large quantities of water from the Neches River to the Trinity River Basin in order to meet the severe water shortages projected to occur in the San Jacinto River Basin and contiguous areas along the Coast by the year 2000. Preliminary design and cost studies have been performed. Water conveyance systems consisting of open channels and pipelines from the Neches River Basin would need to be constructed. Supplies currently available in the Neches River Basin to meet this export need could be depleted by the year 2020. Rockland Reservoir on the Neches River upstream of B.A. Steinhagen Reservoir is proposed for construction by 2020 to meet this need. Rockland Reservoir, as presently authorized, would provide a dependable yield of 682.7 thousand acre-feet annually. Surpluses in excess of in-basin needs and freshwater requirements of the Sabine Lake estuary would be available for conveyance to water-deficient areas provided appropriate institutional arrangements can be consumated.

Additional studies are planned to examine the engineering alternatives and the institutional and environmental considerations that would be involved in implementing such a project. There is clearly an opportunity for such an undertaking to provide for maximum beneficial use of surplus waters over and above in-basin needs and the freshwater requirements of the Sabine Lake estuarine system.

Water Quality Protection

A water quality management plan for the Neches River Basin has been developed pursuant to the requirements of federal and State Clean Water legislation. An areawide water quality management plan has also been developed for the Beaumont-Port Arthur-Orange metropolitan area. The plans serve as a basic element in the State's overall water quality strategy and provide guidance in establishing priorities for construction grants for waste treatment facil-

Table III-6-6. Water Resources of the Neches River Basin, Zone 2, With Projected Water Supplies and Demands, 1990-2030[1]

	Water Supply					Water Demand				Surplus or Shortage		
Decade	In Zone	Intra-Basin	Return Flow	Import	Total	In Zone	Intra-Basin	Export	Total	M & I	Irrigation (Shortage)	Total
1990												
Ground Water	53.2	—	—	—	53.2	53.2	—	—	53.2	.0	.0	.0
Surface Water	919.9	9.8	71.5	5.6	1006.8	231.9	.0	340.6	572.5	436.5	(2.2)	434.3
Total	973.1	9.8	71.5	5.6	1060.0	285.1	.0	340.6	625.7	436.5	(2.2)	434.3
2000												
Ground Water	59.4	—	—	—	59.4	59.4	—	—	59.4	.0	.0	.0
Surface Water	919.9	10.0	82.2	6.4	1018.5	280.9	.0	320.7	601.6	419.1	(2.2)	416.9
Total	979.3	10.0	82.2	6.4	1077.9	340.3	.0	320.7	661.0	419.1	(2.2)	416.9
2010												
Ground Water	68.1	—	—	—	68.1	68.1	—	—	68.1	.0	.0	.0
Surface Water	908.3	10.0	92.9	7.3	1018.5	327.9	.0	522.7	850.6	170.1	(2.2)	167.9
Total	976.4	10.0	92.9	7.3	1086.6	396.0	.0	522.7	918.7	170.1	(2.2)	167.9
2020												
Ground Water	72.7	—	—	—	72.7	72.7	—	—	72.7	.0	.0	.0
Surface Water	1579.4	10.0	105.1	8.5	1703.0	388.8	.0	1013.6	1402.4	302.8	(2.2)	300.6
Total	1652.1	10.0	105.1	8.5	1775.7	461.5	.0	1013.6	1475.1	302.8	(2.2)	300.6
2030												
Ground Water	77.6	—	—	—	77.6	77.6	—	—	77.6	.0	.0	.0
Surface Water	1567.8	10.0	120.0	10.1	1707.9	462.5	.0	1226.8	1689.3	23.3	(4.7)	18.6
Total	1645.4	10.0	120.0	10.1	1785.5	540.1	.0	1226.8	1766.9	23.3	(4.7)	18.6

[1]Units in thousands of acre-feet per year. Water demands are for the "high" case. Tabulated surface water demands do not include livestock needs, some quantities of irrigation needs and other needs which will continue to be met from local, unregulated surface-water supplies.

Definitions

Intra-Basin: A transfer of water among zones within a river basin.
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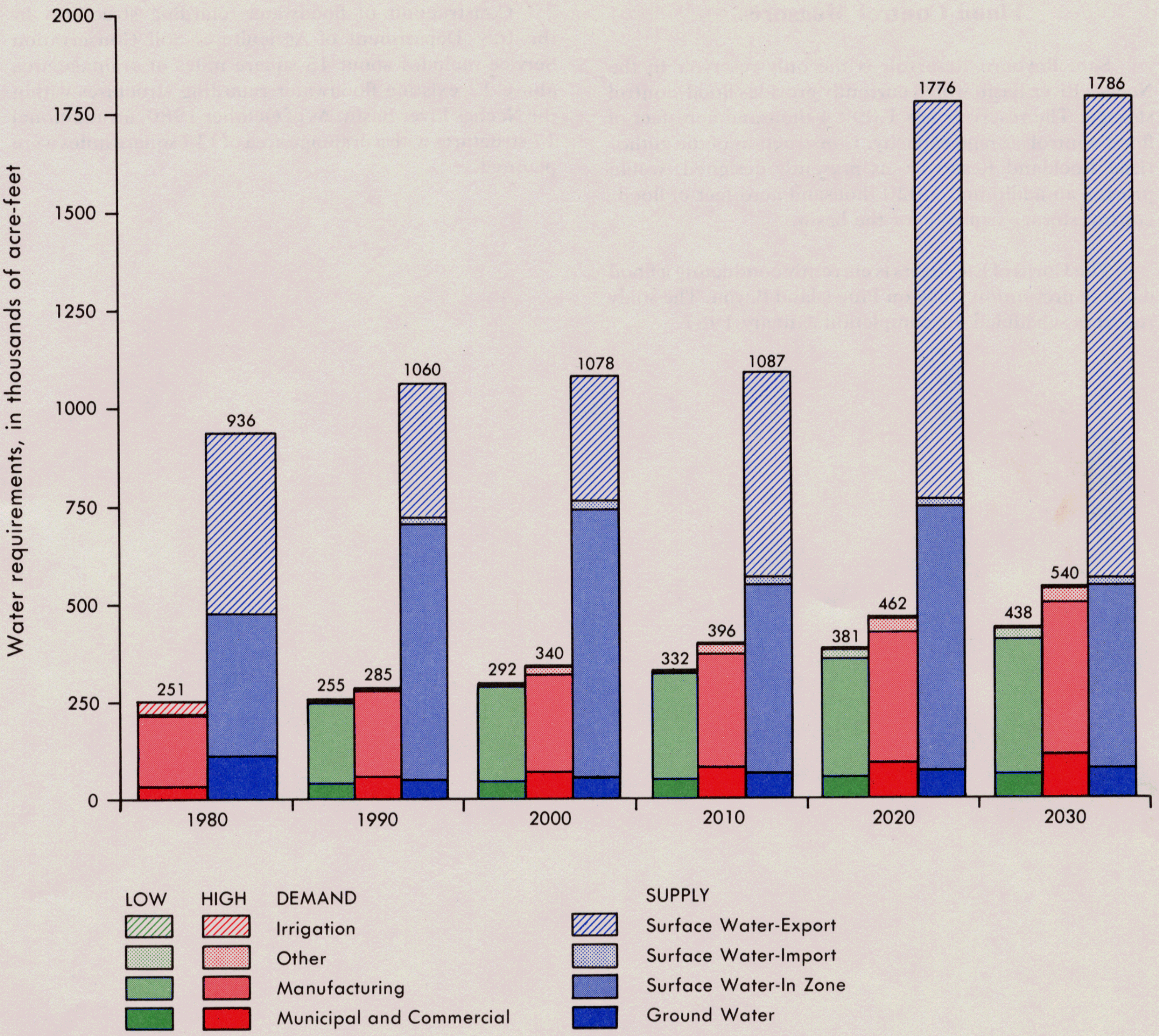

Figure III-6-4. Reported Use and Supply Source, With Projected Water Supplies and Demands, Neches River Basin, Zone 2, 1980-2030

ities, permitting of wastewater facilities, revision of stream standards, and other program activities.

Construction costs associated with municipal wastewater treatment facilities needs have been estimated to be approximately $149.9 million for the planning period of 1980 to the year 2000. These costs are estimated for the entire Neches River Basin with approximately $88.6 million required in Zone 2, while approximately $61.3 million is projected necessary in Zone 1. All costs are in January 1980 dollars and are subject to revision as new data becomes available. The list of projects, with project costs for 1982-1989, at 1980 prices, are shown in Appendix B.

Additional water quality management costs, such as for control of industrial, oil and gas, and agricultural pollutants, cannot be estimated at this time, but are believed to be increasing.

Flood Control Measures

Sam Rayburn Reservoir is the only reservoir in the Neches River Basin which currently provides flood-control storage. The reservoir has 1,099.4 thousand acre-feet of flood control storage capacity. Construction of the authorized Rockland Reservoir, as presently designed, would provide an additional 1,020 thousand acre-feet of flood-control storage capacity for the basin.

The Corps of Engineers is currently conducting a flood damage prevention study on Pine Island Bayou. The study report is scheduled for completion January 1987.

Construction of floodwater-retarding structures by the U.S. Department of Agriculture, Soil Conservation Service includes about 45 square miles of drainage area above 12 existing floodwater-retarding structures within the Neches River Basin. As of October 1980, an additional 17 structures with a drainage area of 117 square miles were planned.